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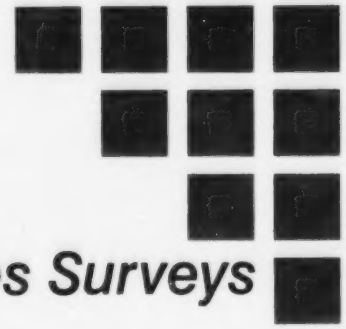


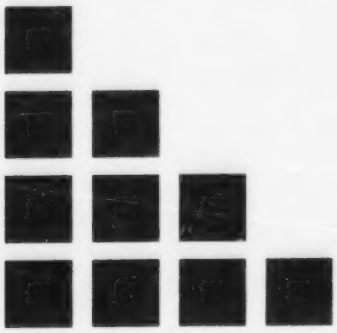
The National Graduates Surveys

Earnings Differences by Detailed Field of Study of University Graduates

R-00-1-5E

by
Daniel Boothby
April 1999

Research Paper



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February 2000

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▬

This report is part of a set of research studies on the National Graduates Surveys.
Le présent rapport fait partie d'un ensemble d'études sur les Enquêtes nationales auprès de diplômés.

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Abstract

This paper seeks to provide a description of the earnings structure by detailed field of study of university graduates at the undergraduate and master's levels. By earnings structure, we mean statistically significant differences between fields of study in average earnings, which are reasonably persistent over time. The study uses data from the National Graduates Surveys and Follow-Up Surveys of graduates in 1990, 1986 and 1982.

Multiple comparison techniques are used to establish groups of fields of study at the undergraduate and master's levels within which we cannot reject the null hypothesis of equal mean earnings. These groups prove to be very broad and individual fields of study are often in different groups in different surveys. We are nonetheless able to establish what we consider to be a reasonable approximation of an earnings structure by field of study.

Differences in the earnings structure between women and men are examined. In fields of study with significant representation of both female and male graduates, the earnings structures for women and men are similar. If fields of study with only small numbers of graduates of one gender are included, the earnings structures of women and men appear to be much less similar.

To examine whether the earnings structure by field of study is related to occupational outcomes by field of study, groups of fields of study are established whose graduates have similar occupational distributions. These groups are derived using cluster analysis.

At the undergraduate level, fields of study can be divided into those whose graduates are highly concentrated in a small range of occupations closely related to the field of study and those in which many graduates work in occupations which are not generally considered to be university-level occupations. For the most part, graduates in the first group of fields of study graduated from professional programs, and earn more than those in the second group. Graduates at the master's level tend to work in occupations closely related to their field of study.

Résumé

Cette étude vise à dresser un profil de la structure de rémunération des diplômés universitaires du premier cycle et des programmes de maîtrise dans différents domaines d'études. Par « structure de rémunération », nous entendons les écarts statistiquement significatifs entre les domaines d'études pour ce qui est de la rémunération moyenne sur une période suffisamment prolongée. L'étude utilise les données provenant des Enquêtes nationales auprès des diplômés et des Enquêtes de suivi réalisées en 1990, 1986 et 1982.

De nombreuses méthodes de comparaison sont utilisées en vue d'établir, aux niveaux du premier cycle universitaire et de la maîtrise, des groupes de domaines d'études à l'intérieur desquels il nous est impossible de rejeter l'hypothèse de différence nulle donnant une rémunération moyenne égale. Ces groupes se révèlent très vastes et un même domaine d'études peut se retrouver dans des groupes différents d'une enquête à l'autre. Nous sommes tout de même en mesure d'établir ce que nous considérons être une approximation raisonnablement juste de la structure de rémunération par domaine d'études.

Les écarts entre les structures de rémunération des hommes et des femmes sont également examinés. Dans les domaines d'études comptant une représentation suffisante de diplômés des deux sexes, les structures de rémunération des hommes et des femmes sont similaires. Lorsque des domaines d'études ne comportant que de petits nombres de diplômés de l'un des deux sexes sont pris en compte, les structures de rémunération des femmes et des hommes semblent se dissocier beaucoup plus.

Afin de déterminer si la structure de rémunération par domaine d'études est fonction de la répartition par profession pour chaque domaine, on regroupe les domaines d'études dont les diplômés ont une répartition professionnelle similaire. Ces groupes sont obtenus au moyen d'une analyse typologique.

Pour le premier cycle universitaire, on peut diviser les domaines d'études entre ceux dont les diplômés sont fortement concentrés dans un petit groupe de professions reliées de près au domaine d'études et ceux dont un grand nombre de diplômés occupent des emplois qui ne sont généralement pas considérés comme étant de niveau universitaire. Dans la plupart des cas, les diplômés du premier groupe avaient étudié dans des programmes professionnels, et gagnaient davantage que ceux du second groupe. Les détenteurs d'une maîtrise travaillent généralement dans des professions étroitement reliées à leur domaine d'études.

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1. Introduction

Do university graduates in some fields of study earn significantly more than those in other fields of study? If one can rank fields of study by earnings in a meaningful way at some point in time, does this ranking persist over time? Answers to these questions are an important element of labour market information, as potential post-secondary students are likely to want information on their earnings prospects in various fields of study. Persistent earnings differences by field of study, if they exist, raise a series of policy-related questions for further research, for example, to what extent these earnings differences are due to restrictions on enrolment in certain fields of study.

Previous research on earnings differences by field of study has used highly aggregated fields of study, which bear little resemblance to the program options that face post-secondary students. This paper uses a detailed field of study aggregation developed by the Canadian Occupational Projections System (COPS). This aggregation is much closer to the students' set of program choices than are the broader groupings used in previous research. The paper provides a description of the structure of earnings differences among detailed fields of study for persons receiving undergraduate degrees or certificates and for persons receiving master's degrees or graduate certificates. The data used are drawn from the 1984, 1988 and 1992 National Graduates Surveys (NGS) and 1987, 1991 and 1995 Follow-Up Surveys of graduates in 1982, 1986 and 1990.

Some correlates of earnings differences among fields of study are also examined here. In particular, fields of study are grouped on the basis of the occupational distribution of their graduates to see whether fields of study with similar occupational distributions tend to occupy similar positions in the earnings distribution. As well, the relation between gender, field of study and earnings is considered.

The paper is organized as follows. The first section discusses what is meant by a structure of earnings by field of study and reviews previous research on this subject for Canada. The second section presents information on field of study differences in earnings drawn from the NGS and Follow-Ups. The third section presents a grouping of fields of study on the basis of the similarity of the occupations their graduates enter and examines the relation between similarity of occupational distribution and similarity of earnings. The fourth section draws conclusions and suggests possible directions for future research.

2. Structure of Earnings Differences

2.1 Definition

If one examines average earnings by field of study of graduates from some level of study, there will be differences in these averages. It is also true that if one compares average earnings for groups of graduates chosen at random, these averages will vary as well. To be able to describe a structure of earnings by field of study, we must be able to reject the hypothesis that the earnings difference between two fields of study at different levels in this structure is due to chance. In other words, fields of study at different levels in the earnings structure must have statistically significant differences in their average earnings.

There is also a time dimension to the earnings structure. A meaningful structure of earnings by field of study is not likely to be fixed for all time. Neither is it likely to vary rapidly. Even if earnings differences between fields of study were statistically significant at any point in time, the idea of an "earnings structure" would be called into question if the relative position of fields of study seemed to vary randomly over a relatively short interval. Thus in our view, a structure of earnings by field of study requires statistically significant differences between average earnings in fields of study at different levels in the structure and requires a reasonable degree of stability of the structure over time. Ideally, one would also be able to explain changes in the earnings structure over time in terms of the supply and demand for various types of skill.

2.2 Previous Research

In light of this discussion of the requirements of an earnings structure by field of study, we will now briefly review previous research on earnings differences by field of study in Canada. There are very few Canadian studies which explicitly examine earnings differences by field of study. Finnie (1999) uses the same data sources as our study, the NGS and Follow-Up Surveys of the 1982, 1986 and 1990 graduation cohorts.

Finnie reports the results of three regression models of the earnings of "bachelor's level" graduates.[1] The first model uses only field of study dummy variables as regressors; the second

[1] In the 1982 cohort, the bachelor's level includes undergraduate certificates, university bachelor degrees and university first professional degrees. From Finnie's paper, it is not clear exactly what is meant by "bachelor's level" for each cohort.

model adds a series of individual characteristics; and the third model adds dummy variables for occupation and industry. Each model is estimated separately for women and men for all six surveys.

Ten field of study groups are used in Finnie's estimates. The field of study coefficients are quite consistent over time and for the most part are similar for women and men. The fields with above average earnings are Other Health, Engineering and Computer Science, Mathematics/Physics and Commerce; those with below average earnings are Arts and Humanities, Other Social Sciences and Agricultural and Biological Sciences; and Education and Economics have roughly average earnings levels.

Finnie thus shows that graduates in certain fields of study at the bachelor's level tend to have earnings that are above average for the level, while graduates in other fields of studies have earnings that are below average for the level. These effects are not statistically significant in every case. There is no attempt made to test whether the differences between average earnings levels in various fields of study are statistically significant, for example, whether earnings levels in Engineering and Computer Science are significantly greater than those in Mathematics/Physics.

Côté and Sweetman (1998) use data from the ninth cycle of the General Social Survey (GSS) to examine field of study effects on three labour market indicators for post-secondary graduates. The indicators used are the weeks of work in the year, the weekly hours of work and the hourly wage. Since the hourly wage is the only indicator of earnings these authors use, we will concentrate on their results concerning field of study effects on the hourly wage.

Côté and Sweetman use six highly aggregated fields of study: Business, Science, Engineering, Social Science, Fine Arts and Humanities and Education. Using their set of regression results with the fewest additional variables beyond field of study, they find that for women, Science, Engineering and Business graduates have significantly higher wages than Social Science and Fine Arts and Humanities graduates. Graduates in Science and Engineering have significantly higher wages than graduates in Education. For men, using the same regression specification, Science and Engineering graduates have significantly higher wages than graduates in Fine Arts and Humanities and Education. There is no statistically significant difference in wages among

male graduates in Science, Engineering, Social Science and Business. All of these comparisons were based on pairwise tests of the null hypothesis of equality of coefficients.

A particularly interesting aspect of Côté and Sweetman's work is that they attempt to model field of study choice, and then use an instrumental variables approach to estimating field of study differences with field of study choice treated as endogenous. For women, they are unable to reject the hypothesis that field of study choice is exogenous, using the variables available to model this choice.[2] For men, exogeneity of field of study is rejected, and wage differences among fields of study tend to increase once field of study is treated as endogenous.

This would mean, for instance, that the wage gain for a male graduate in Science over his wage if he had enrolled in Fine Arts and Humanities is greater than the wage gain a randomly selected male individual would realize by completing studies in Science, rather than in Fine Arts and Humanities. Men may be self-selecting into the fields of study where their potential is greatest. This result is similar to those of a series of studies on the return to education in the United States which suggest that individuals who acquire a university education have greater earnings gains on average from a university education than would a randomly selected high school graduate.

Wannell and Caron (1994) examine the male-female earnings gap for post-secondary graduates controlling for field of study. They do not report the field of study coefficients from their regression analysis. The fields of study used in their regressions are quite detailed. Wannell and Caron do provide figures showing average earnings levels for female and male university and community college graduates in nine broad fields of study. The earnings ranks of university fields of study appear to be very similar for women and men.

The papers discussed above examine earnings levels of graduates. Another body of research, which provides comparisons of outcomes by field of study, reports estimates of rates of return to post-secondary education or the present values of a post-secondary education. For example, Dodge and Stager (1972) report estimates of the net present value and the private and social rates of return of university undergraduate and post-graduate education in science, engineering and

[2] The authors interpret this as meaning that they have failed to model women's choice of field of study using the variables available, and not as meaning that this choice could not be modeled using a more complete set of variables.

business. Mehmet (1977) reports private rates of return to bachelor's degrees in twenty-one fields of study. Mehmet also provides information on starting salaries in these fields of study.

Vaillancourt (1996) reports estimates of private and social rates of return for secondary education and various levels of post-secondary education using earnings data from the 1991 Census. The results for post-secondary levels of study are given by broad field of study. This paper contains a synoptic table of Canadian studies of the rate of return to education. In addition to the two studies cited in the previous paragraph, others of these studies provide field of study detail. Vaillancourt (1998) compares the results of Vaillancourt (1996) from 1991 Census data with rates of return computed from 1986 Census data.

Appleby et al. (1999) use the LifePaths simulation model to provide estimates of distributions of individual private rates of return by detailed field of study for BA and first professional degree graduates and for community college graduates. The earnings data used in the simulation model are drawn from the 1991 Census; the data on the duration of studies are drawn from individual longitudinal records constructed from administrative data.

Their results show median rates of return by field of study at the university undergraduate level that range from 7% to 15% with three exceptions (2% for Religion and Theology, 22% for Dentistry and 23% for Medicine). The range of individual rates of return from the 30th percentile to the 70th percentile is at least 15 percentage points within each field of study. Consequently, even those fields of study with very different median rates of return have considerable overlap in their distributions of individual rates of return. In other words, an individual graduate is better off doing well in a field of study with a low median rate of return than doing poorly in a field of study with a high median rate of return.

To summarize, we have found no recent research comparing average earnings levels for detailed fields of study for university graduates in Canada (with the possible exception of the unpublished regression results of Wannell and Caron, 1994). In research on the rate of return to education in Canada, several studies provide estimates by field of study, but only one, Appleby et al. (1999) does so at a detailed field of study level.

Finnie's (1999) research using the NGS and Follow-Up Surveys indicates that Bachelor's level graduates in Other Health, Engineering and Computer Science, Mathematics/Physics and Commerce have above average earnings for this level of study, while graduates in Arts and Humanities, Other Social Sciences and Agricultural and Biological Sciences have below average earnings. Using data from Cycle 9 of the GSS, Côté and Sweetman find that for women, Science, Engineering and Business graduates have significantly higher wages than Social Science and Fine Arts and Humanities graduates, while male Science and Engineering graduates have significantly higher wages than male graduates in Fine Arts and Humanities and in Education.

3. Earnings Differences by Detailed Field of Study

In this section, we present evidence on the structure of earnings by detailed field of study at the undergraduate and post-graduate (other than doctoral) levels. We recall the requirements for an "earnings structure" that we stated in the first section: first, that fields of study at different levels in the earnings structure should have average earnings which are significantly different (in a statistical sense); second, that the structure should show a reasonable degree of stability over time.

To meet the first of these requirements, for each pair of fields of study we need to test the null hypothesis that their average earnings levels are equal. In most cases, we are working with more than thirty fields of study. This means that there are more than four hundred pairs of fields of study for which the tests of equality of means need to be carried out. This large number of comparisons dictates the use of techniques of multiple comparison analysis.[3]

Before presenting the results of this analysis, we give an overview of the data used in these comparisons. As stated above, these data are derived from the 1984, 1988 and 1992 NGS and 1987, 1991 and 1995 Follow-Up Surveys of the 1982, 1986 and 1990 graduation cohorts.[4] We give results for two levels of study: the university undergraduate level, which includes undergraduate certificates, bachelor's degrees and first professional degrees, and the master's level, which includes graduate certificates and master's degrees. It would undoubtedly have been preferable to exclude persons receiving undergraduate certificates and those receiving graduate certificates from our samples. It is not possible to do so for the 1982 graduation cohort, however. To preserve comparability across the three graduation cohorts, we were forced to include persons receiving undergraduate certificates in the undergraduate level and those receiving graduate certificates in the master's level.

---

3 Suppose we carried out ordinary t-tests of the null hypothesis of the equality of the means at the 1% significance level for all pairings of 30 fields of study. Under the assumption of independence of these tests, in four hundred tests the probability of at least once rejecting the null hypothesis when it is true is .99. Multiple comparison techniques avoid this problem by using test procedures which control the "maximum experimentwise error rate," that is, the expected probability of at least one type I error. See Appendix C for further details.

4 The data sets used are the combined data files for the NGS and the Follow-Up Survey made available to HRDC under the information-sharing agreement. These differ from the Statistics Canada master files in that a small number of respondents who refused to have their interviews shared with HRDC are excluded from the sample.

The National Graduates Surveys

The National Graduates Surveys (NGS), sponsored by Human Resources Development Canada and conducted by Statistics Canada, are specifically designed to obtain information on the relationship between education/training and labour market activities, the long-term labour market experiences of graduates, the employment, earnings, occupation and additional educational experiences and qualifications of graduates. The NGS focus on individuals who had obtained a degree, diploma or certificate from a trade/vocational school, a career/technical college (or CEGEP) or a university, and who were still living in Canada at the time of the survey. The NGS files are representative of the underlying graduate population in Canada.

Background

Statistics Canada conducted a first survey in 1978 on the labour market experiences of 1976 graduates from universities and community colleges in Canada. In 1984, a similar survey, the NGS of 1982 graduates was sponsored jointly by the Department of the Secretary of State and Employment and Immigration Canada and conducted by Statistics Canada. This survey expanded on the content of the previous survey and extended the population base to include graduates of trade/vocational programs in addition to graduates from community colleges and universities.

Since 1982, four cohorts of graduates have been surveyed. Every cohort was interviewed two and five years after graduation.

Year of graduation	First interview	Follow-up interview
1982	1984	1987
1986	1988	1991
1990	1992	1995
1995	1997	2000

The 2000 Follow-up Survey of the 1995 Graduates included a 'brain drain' component. Those who graduated in 1995 but who were living in the United States in June 2000 were included in the survey.

Objectives

The survey's key data objectives are:

- To obtain information for labour market analysis;
- To obtain information on the relationship between education/training and labour market experiences and the exposure of graduates to additional learning opportunities;
- To extend available information required to improve occupational supply and demand projection models and to conduct related studies of supply-demand imbalances in the labour market;
- To extend available information required to improve occupational supply and demand projection models and to conduct related studies of supply-demand imbalances in the labour market;
- To obtain data regarding longer-term market experiences of graduates;
- To obtain information on labour market experiences of members of target groups (such as women, visible minorities, native people, and persons with disabilities);

- To gain a better understanding of school-work transitions and returns to human capital;
- To gain a better understanding of post-secondary education financing;
- To obtain more detailed information on knowledge and skills.

Methodology

The National Graduates Surveys were based on a stratified systematic random sample design. For each province, the graduate population was stratified into five education levels: trade/vocational (skilled trades), career/technical (college), undergraduate, master's level and doctorate. The levels were subsequently stratified into nine fields of study for those who had taken a college program and ten fields for trade/vocational and university graduates. These fields of study classifications were based on the 5-digit USIS (University Student Information System) and CCSIS (Community College Student Information System) codes used by Statistics Canada. The sample allocation to the strata was made to assure acceptable levels of detail and therefore acceptable data reliability for the provinces, education levels and fields of study.

A total sample was selected for every cohort of graduates. Interviewers attempted to contact all graduates in the sample, initially using the telephone numbers provided by their institution. On average for every cohort, 73% of the total sample selected were contacted and interviewed. The same individuals were contacted again for the follow-up interview.

Year of graduation	Total sample selected	Year of survey	Usable sample (response rate)
1982	49,150	1984	35,717 (73%)
		1987	31,167
1986	53,136	1988	40,814 (77%)
		1991	35,401
1990	51,111	1992	36,280 (71%)
		1995	35,816
1995	61,759	1997	43,040 (70%)
		2000	To be completed

For more detailed information on methodology, see:

Clark, Warren, Margaret Laing and Edith Rechnitzer (1986). *The Class of 82: Summary Report on the Findings of the 1984 National Survey of the Graduates of 1982*, Secretary of State and Statistics Canada.

Clark, Warren (1991). *The Class of 1986: A Compendium of Findings of the 1988 National Graduates Survey of 1986 Graduates with Comparisons to the 1984 National Graduates Survey*, Employment and Immigration Canada and Statistics Canada, Catalogue LM-198E92.

Little, Don and Louise Lapierre (1996). *The Class of 90: A Compendium of Findings from the 1992 National Graduates Survey of 1990 Graduates*, Human Resources Development Canada and Statistics Canada, Catalogue SC-125-12-96E.

Taillon, Jacques and Mike Paju (1999). *The Class of '95: Report of the 1997 National Survey of 1995 Graduates*, Human Resources Development Canada and Statistics Canada, Catalogue SP-121-04-99.

The earnings levels for fields of study are those of graduates working full-time. Since earnings are reported on the basis of full-year equivalents in the NGS, the earnings variable is conceptually full-year, full-time earnings.[5] Consequently, none of the variance in earnings among graduates in the same level and field of study can be due to differences in weeks worked or in full-time/part-time status.

The sample for earnings (and for other job-related variables) is restricted to persons who had completed no further education beyond the degree or certificate that lead to their inclusion in the NGS sample by the interview at which the job-related information was collected.[6] This restriction seeks to ensure that the earnings sample for a field of study is restricted to persons whose most recent studies are in that field of study. (Appendix A lists all of the sample selection criteria used in each of our estimates.)

The COPS field of study grouping used in our analysis includes fifty-eight fields of study at the university level (one of which is the residual field "no specialization"). These fields of study and their mapping from USIS field of study codes are given in Appendix B. In most cases, these fields of study correspond with university departments, for example, sociology or mechanical engineering. In some cases, usually residual categories, the level of aggregation is somewhat broader than a university department. We were not able to report results for some COPS fields of study in some or all cases due to insufficient sample size. The number of fields of study reported varies among the different tables and figures, due to differing sample size restrictions. (See Appendix A for more detail).

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5 It would have been possible to construct an hourly earnings variable by dividing reported earnings by usual hours worked x 52. Mean hourly earnings constructed by methods of this type tend to have very high standard errors, which makes it more difficult to reject the null hypothesis of equality of means. Consequently, we chose to use the reported earnings variable for full-time workers, rather than a constructed hourly earnings variable for all workers.

6 For example, a 1990 graduate who had completed further education by the 1992 interview would be excluded in both 1992 and 1995. A graduate who had not completed further education by 1992, but had by 1995, would be excluded in 1995, but not in 1992.

3.1 Earnings Structure at the Undergraduate Level

Mean Earnings

Figures 1a and 2a show, by field of study, mean earnings levels in 1992 and 1995 and these levels plus and minus two standard errors, for 1990 graduates at the undergraduate level.[7] The means are shown sorted in ascending order from left to right. The high earnings outlier in 1992 is Dentistry; the outlier in 1995 is Medicine. (Dentistry had insufficient sample size in 1995 to be included.) Some of these means have very large standard errors. Even if we ignore the cases with large standard errors, it is clear that there will be large groups of fields of study in which we cannot reject the hypothesis of equality of means.

Figures 1b and 2b show mean earnings levels and two standard error intervals by field of study for 1986 graduates in 1988 and 1991 respectively. The fields of study in Figure 1b are sorted by earnings rank in 1992. This allows comparison of the earnings rank of the fields of study in 1992 with their earnings rank in 1988. If the earnings ranks were identical in the two years, the mean earnings in Figure 1b would increase monotonically from right to left as in Figure 1a. Similarly, the fields of study in Figure 2b are sorted by earnings rank in 1995 to allow comparisons of earnings rank between 1995 and 1987.

Figures 1c and 2c show mean earnings levels and two standard error intervals by field of study for 1982 graduates in 1984 and 1987 respectively, sorted by earnings rank in 1992 for Figure 1c and in 1995 for Figure 2c. Again, this is to allow comparisons of 1984 earnings rank with 1992 earnings rank and of 1987 earnings rank with 1995 earnings rank. The mean earnings levels in each NGS (1992, 1988 and 1984) are sorted in the order of the most recent NGS used (1992); and the mean earnings levels for each Follow-Up Survey (1995, 1991, 1987) are sorted in the order of the most recent Follow-Up (1995).

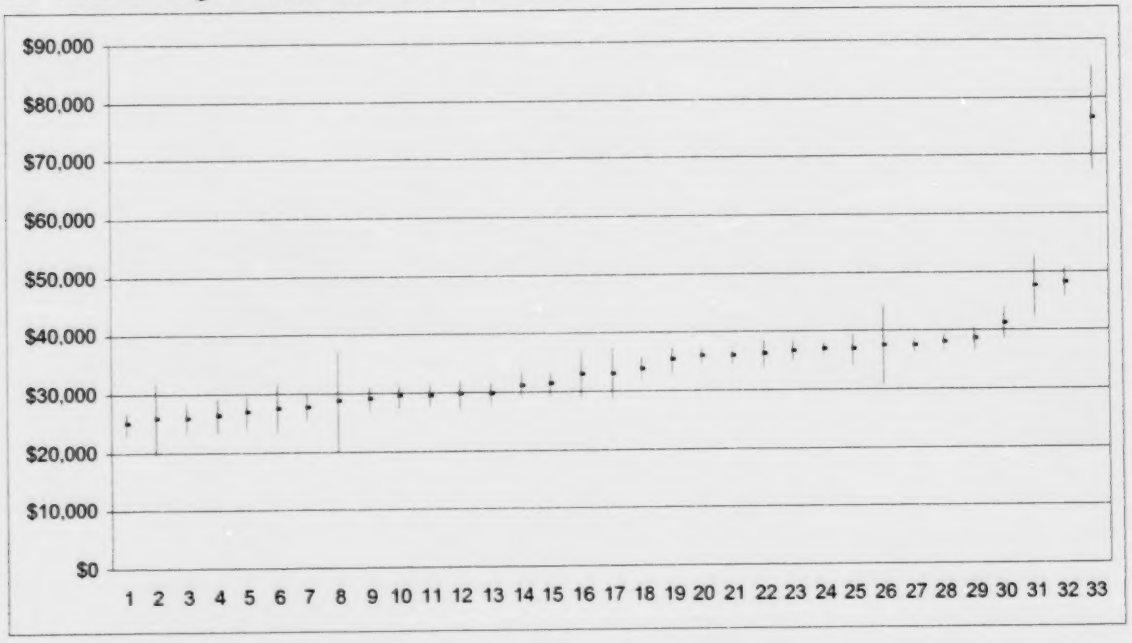
From these figures it is immediately obvious that the ordering of fields of study by mean earnings level varies considerably over time. What is less obvious is that the higher earning group of fields of study tends to remain the same over time. One way to see this is to envisage passing a

[7] There are 58 COPS fields of study at the university level. There are only 33 fields of study included in Figure 1 and 32 fields of study included in Figure 2 because of the requirement that the field of study have sufficient sample size in all three NGS (for Figure 1) or in all three Follow-Up Surveys (for Figure 2). See Appendix A for the detail of sample size restrictions in the different tables and figures.

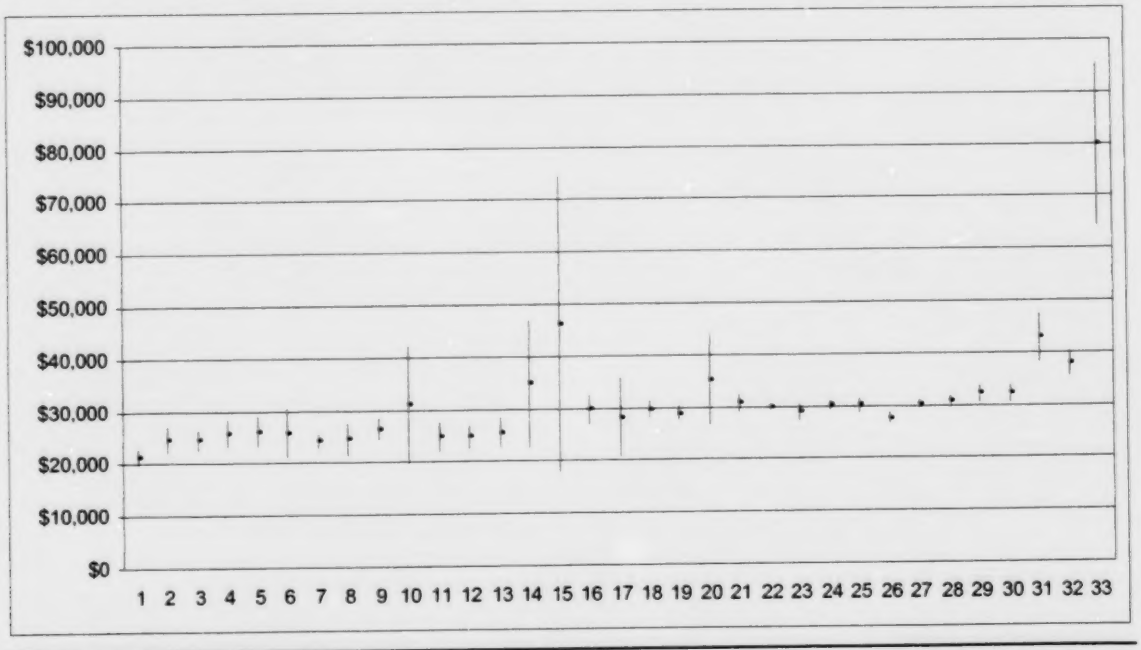
regression line through the points in Figures 1b, 1c, 2b and 2c (omitting the Dentistry/Medicine outliers). The line will slope upwards from left to right.

Figure Series 1 **Mean Earnings by Field of Study at the Undergraduate Level 1992, 1988 and 1984 National Graduates Surveys (1992 Order)**

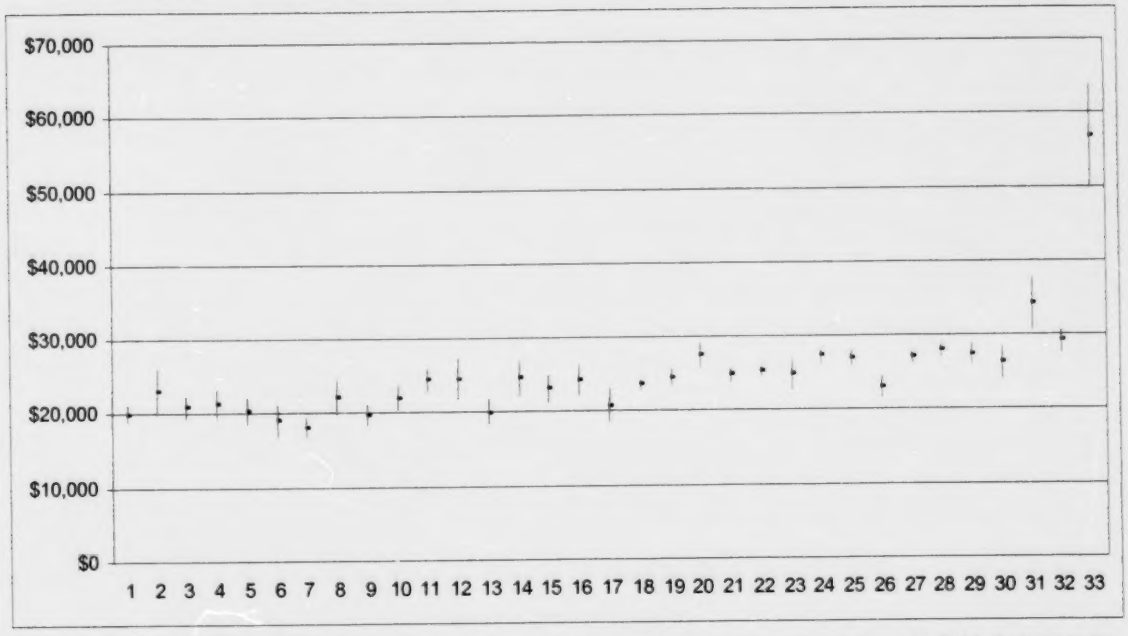
1a 1992 Earnings of 1990 Graduates



1b 1988 Earnings of 1986 Graduates



1c 1984 Earnings of 1982 Graduates



Notes: Figures 1a, 1b and 1c give the mean earnings of graduates at the undergraduate level by field of study in the National Graduates Surveys of 1992 (1a), 1988 (1b) and 1984 (1c). The dark point is the mean earnings for the field of study; the range indicated by the vertical line segment is plus or minus two standard errors.

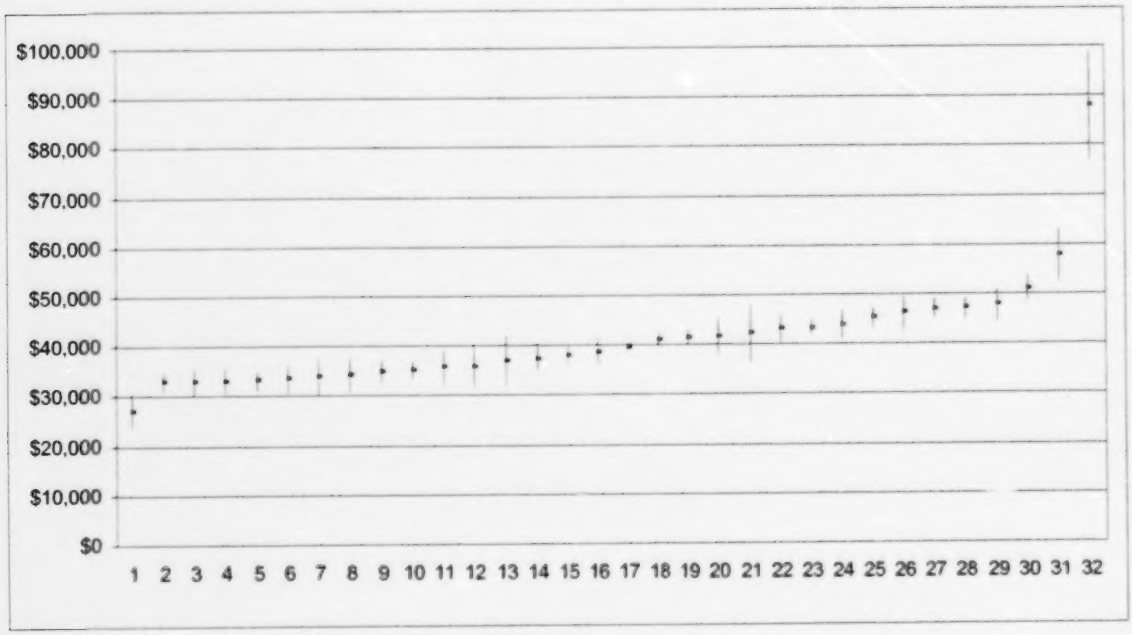
In Figures 1a, 1b and 1c the fields of study are arranged in ascending order of mean earnings in 1992 as listed below. The numbers on the horizontal axis correspond to the number in the list. Among the thirty-three fields of study which are shown in Figure 1, field of study 1, Biology, had the lowest mean earnings in 1992 and field of study 33, Dentistry, had the highest mean earnings in 1992.

Fields of Study in Figure Series 1 by Earning Rank in 1992 (Ascending Order)

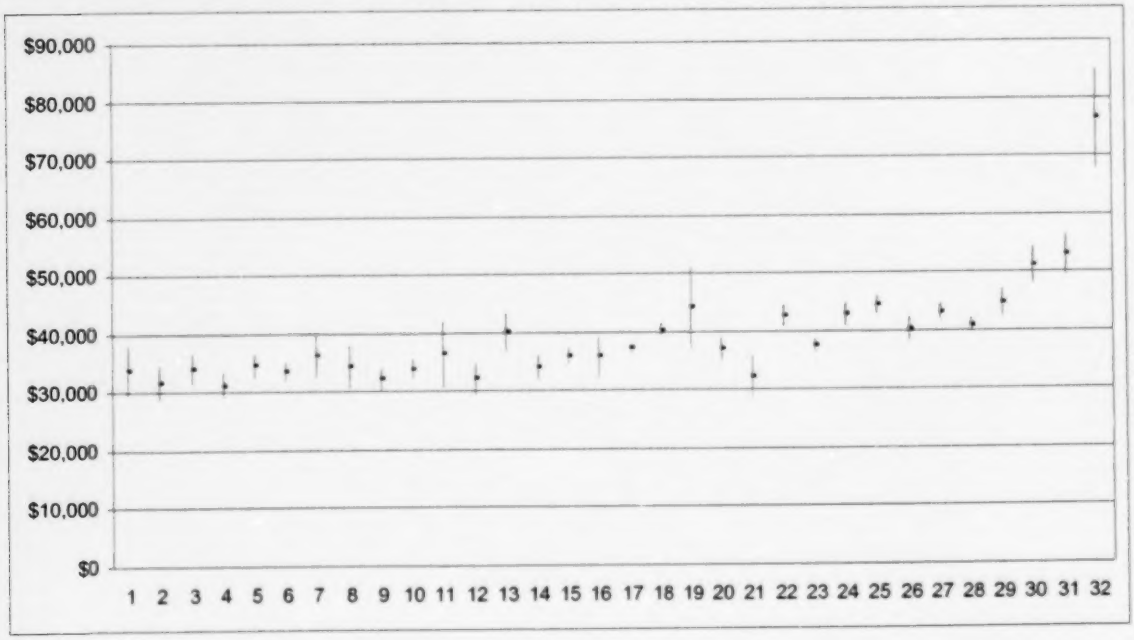
1. Biology
2. Fine and Performing Arts (Except Music)
3. English
4. Geography
5. History
6. Other Biological Sciences
7. Food and Household Sciences
8. Agriculture (except Animal and Plant Sciences)
9. Physical Education
10. Sociology
11. Psychology
12. French
13. Political Science
14. Economics
15. Teaching (Except Elementary/Secondary and Physical Education)
16. Specialized Administration
17. Religion/Theology
18. Commerce
19. Mathematics
20. Mechanical Engineering
21. Rehabilitation Medicine
22. Elementary/Secondary Teacher Training
23. Civil Engineering
24. Computer Science
25. Other Engineering
26. Social Work and Social Welfare
27. Nursing
28. Electrical Engineering
29. Chemical Engineering
30. Law
31. Medicine
32. Pharmacy
33. Dentistry

Figure Series 2 Mean Earnings by Field of Study at the Undergraduate Level 1995, 1991 and 1987 Follow-up (1995 Order)

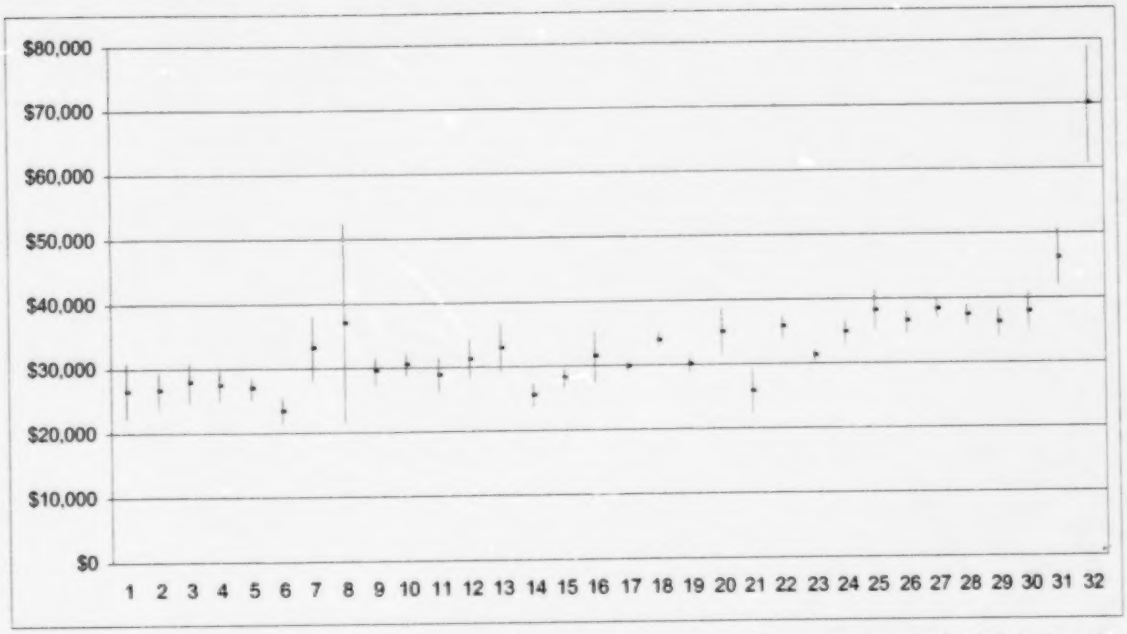
2a 1995 Earnings of 1990 Graduates



2b 1991 Earnings of 1986 Graduates



2c 1987 Earnings of 1982 Graduates



Notes: Figures 2a, 2b and 2c give the mean earnings of graduates at the undergraduate level by field of study in the Follow-Up Surveys of 1995 (2a), 1991 (2b) and 1987 (2c). The dark point is the mean earnings for the field of study; the range indicated by the vertical line segment is plus or minus two standard errors.

In Figures 2a, 2b and 2c the fields of study are arranged in ascending order of mean earnings in 1995 as listed below. The numbers on the horizontal axis correspond to the numbers in the list. Among the thirty-two fields of study which are shown in Figure 2, field of study 1, Fine and Performing Arts (except Music), had the lowest mean earnings in 1995 and field of study 32, Medicine, had the highest mean earnings in 1995.

Fields of Study in Figure Series 2 by Earning Rank in 1995 (Ascending Order)

1. Fine and Performing Arts (except Music)
2. Teaching (except Elementary/Secondary and Physical Education)
3. Geography
4. English
5. Biology
6. Food and Household Science
7. Chemistry
8. Other Biological Sciences
9. Sociology
10. Psychology
11. History
12. French
13. Specialized Administration
14. Physical Education
15. Social Work and Social Welfare
16. Political Science
17. Elementary/Secondary Teacher Training
18. Commerce
19. Rehabilitation Medicine
20. Economics
21. Religion/Theology
22. Civil Engineering
23. Nursing
24. Mathematics
25. Mechanical Engineering
26. Other Engineering
27. Electrical Engineering
28. Computer Science
29. Chemical Engineering
30. Pharmacy
31. Law
32. Medicine

A more formal method of showing that earnings ranks are similar over time is to examine their correlation across the different surveys. Table 1 gives ordinary (Pearson) correlation coefficients and rank (Spearman) correlation coefficients among mean earnings in fields of study in the three NGS and the three Follow-Up Surveys.[8] The correlations are high, indicating a significant degree of stability in the earnings structure over time.

Table 1 **Correlation in Earnings by Field of Study across Surveys: Undergraduate Level**

	NGS			*Follow-Up*		
	1992-1988	**1992-1984**	**1988-1984**	**1995-1991**	**1995-1987**	**1991-1987**
Ordinary	.77	.86	.76	.84	.76	.80
Rank	.89	.95	.91	.95	.93	.93
n	33			32		

Earnings Structure

We now turn to an attempt to describe the earnings structure of undergraduate fields of study, using the tools of multiple comparisons. In particular, we used the Tukey-Kramer method to carry out comparisons of the mean earnings levels by field of study for each of our six data sets. The procedure used generates a list of groups of fields of study within which one cannot reject the hypothesis of equality of mean earnings.[9] (See Appendix C for further details.)

We then selected among these groups of fields of study as follows: we began with the group that contained the field of study with the highest mean earnings. The next group was the group which 1) contained the field of study with the highest mean earnings among those not in the first group and 2) had the least overlap with the first group. We then proceeded in a similar manner with the second group, and so on. At the end of the process, all fields of study were in at least one group (but no more than two groups), and the top-down overlap between the groups was minimized. (A sample output and example of this process are included in Appendix C.)

The results of this process are reported in Table 2. For example, Table 2 shows that in 1995, the field of study Medicine was in the first (highest earnings) group of five groups of fields of study,

8 Spearman correlation coefficients are ordinary correlation coefficients computed on ranks.

9 More specifically, we used the Tukey option in PROC GLM in SAS with the significance level at its default value of .05. As recommended for this procedure, unweighted data were used. The groups discussed in the text were generated using the LINES option. In principle, a balanced design is preferred with this option, but we did not have equal cell sizes.

denoted 1/5. Medicine was in fact the only member of this group. In the same year, Computer Science was in both the second and third groups, denoted 2,3/5.

Consequently, one cannot reject the hypothesis of equality of mean earnings in Computer Science and in Law, since both are in the second group, nor can one reject the hypothesis of equality of mean earnings between Computer Science and Social Work and Social Welfare, since both are in the third group. One can, however, reject the hypothesis of equality of mean earnings between Law and Social Work and Social Welfare, since the former is in the second group and the latter is in the third group.

The horizontal lines in Table 2 represent an attempt at defining an earnings structure for undergraduate fields of study. The fields of study grouped by these lines seem to fall in roughly similar positions in the earnings ranking across the various NGS and Follow-Up Surveys. A brief examination of the table shows that this classification cannot be very precise, and becomes less precise as one moves down the table. It is often not possible to reject the hypothesis of equality of mean earnings between fields of study separated by one or even two lines. Despite the considerable overlap of earnings group across the horizontal lines, in our opinion the lines we have drawn represent persistent differences in the earnings ranking of fields of study.

One could summarize the earnings structure for undergraduate fields of study shown in Table 2 as follows: Medicine and Dentistry are at the top of the earnings distribution, followed by Law and Veterinary Medicine. The next group consists of Pharmacy, the engineering fields of study and Computer Science and Mathematics. This is followed by a group containing two female-dominated health fields of study (Nursing and Rehabilitation Medicine), two professional programs in which women are heavily represented (Elementary/Secondary Teaching and Social Work and Social Welfare) and three business-related programs, Commerce, Specialized Administration and Economics.

Finally, there is a broad group containing a variety of science, social science, humanities and arts fields of study. Within this group, Fine and Performing Arts, except Music, is notable in that in every survey it is in the lowest earnings group of fields of study, and in this group only.

Table 2 **Earnings Group of Fields of Study: Undergraduate Level**

Field of Study	NGS			Follow-Up		
	1992 group	1988 group	1984 group	1995 group	1991 group	1987 group
Medicine	2/3	2/3	2/4	1/5	2/6	2/5
Dentistry	1/3	1/3	1/4		1/6	1/5
Law	2/3	2,3/3	3/4	2/5	3/6	3/5
Veterinary Medicine	2/3	2/3	3/4	2/5	3/6	
Pharmacy	2/3	2/3	2/4	2/5	3,4/6	3,4/5
Chemical Engineering	2/3	2,3/3	3/4	2/5	4/6	4/5
Electrical Engineering	2/3	2,3/3	2,3/4	2/5	4/6	3/5
Other Engineering	2,3/3	2,3/3	3/4	2/5	4,5/6	4/5
Computer Science	2,3/3	2,3/3	3/4	2,3/5	4,5/6	4/5
Mechanical Engineering	2,3/3	2,3/3	3/4	3/5	4/6	3/5
Civil Engineering	2,3/3	3/3	3/4	3/5	4,5/6	4/5
Mathematics	2,3/3	3/3	3/4	3/5	4,5/6	4/5
Nursing	2,3/3	2,3/3	3/4	3/5	5,6/6	4,5/5
Rehabilitation Medicine	2,3/3	2,3/3	3/4	3,4/5	4/6	4,5/5
Commerce	2,3/3	3/3	3/4	3,4/5	5,6/6	4,5/5
Specialized Administration	2,3/3	3/3	3/4	3,4/5	5,6/6	4/5
Economics	3/3	3/3	3/4	3,4/5	5,6/6	4/5
Elementary/Secondary Teaching	2,3/3	3/3	3/4	3,4/5	5,6/6	4,5/5
Social Work/Social Welfare	2,3/3	3/3	3/4	3,4/5	5,6/6	4,5/5
History	3/3	3/3	4/4	4/5	6/6	4,5/5
Political Science	3/3	3/3	4/4	4/5	5,6/6	4,5/5
Chemistry	3/3		3,4/4	4,5/5	5,6/6	4,5/5
Biological Sciences, except Agriculture/Biology	3/3	3/3	4/4	4,5/5	5,6/6	4/5
Agriculture, except Animal/Plant Science	3/3	3/3	3/4		5,6/6	4/5
Geology		3/3	3/4		5,6/6	4,5/5
Forestry		3/3	3,4/4		5,6/6	4,5/5
Physical Education	3/3	3/3	4/4	3,4/5	6/6	5/5
Religion/Theology	3/3	2,3/3	4/4	3,4/5	6/6	5/5
Sociology	3/3	3/3	4/4	4,5/5	6/6	4,5/5
Food and Household Sciences	3/3	3/3	4/4	4,5/5	6/6	5/5
Biology	3/3	3/3	4/4	4,5/5	6/6	5/5
French	3/3	3/3	3/4	4,5/5	6/6	4,5/5
Geography	3/3	3/3	3,4/4	4,5/5	6/6	4,5/5
Teaching, except Elementary/Secondary	3/3	2/3	3/4	4,5/5	6/6	4,5/5
Psychology	3/3	3/3	3,4/4	4,5/5	6/6	4,5/5
English	3/3	3/3	3,4/4	4,5/5	6/6	4,5/5
Fine and Performing Arts, except Music	3/3	3/3	4/4	5/5	6/6	5/5

Notes: In each NGS and Follow-Up Survey shown in Table 2, every field of study shown belongs to either one or two groups of fields of studies. These groups are constructed using the procedure described in the text and in Appendix C. The lowest numbers are the highest earnings groups; the highest numbers the lowest earnings group. In 1992, the 2/3 for Medicine indicates that it is in the second of three earnings groups, while the 2,3/3 for Commerce indicates that it is in both the second and the third of the three earnings groups. The horizontal lines divide fields of which seem to fall in about the same earnings ranking across the six surveys.

3.2 Earnings Structure at the Master's Level

Mean Earnings

In this subsection, we will present essentially the same information on the earnings structure at the master's level (including graduate certificates) that we presented for the undergraduate level

in the preceding subsection. Figure 3 shows mean earnings levels by field of study and a two standard errors interval for master's level graduates in the 1992 (3a), 1988 (3b) and 1984 (3c) NGS. Figure 4 shows mean earnings levels by field of study and a two standard errors interval for master's level graduates in the 1995 (4a), 1991 (4b) and 1987 (4c) Follow-Up Surveys. As in Figures 1 and 2, the fields of study are sorted by 1992 earnings rank for the NGS and by 1995 earnings rank for the Follow-Up Surveys.

The conclusions we drew for the undergraduate level from Figures 1 and 2 apply in large part to the master's level as shown in Figures 3 and 4. There are broad groups of field of study in which it is difficult to reject the equality of mean earnings. The exact ordering of fields of study by earnings changes from survey to survey, but high earnings fields of study tend to remain in the upper end of the earnings distribution, while low earnings fields of study tend to remain in the lower end.

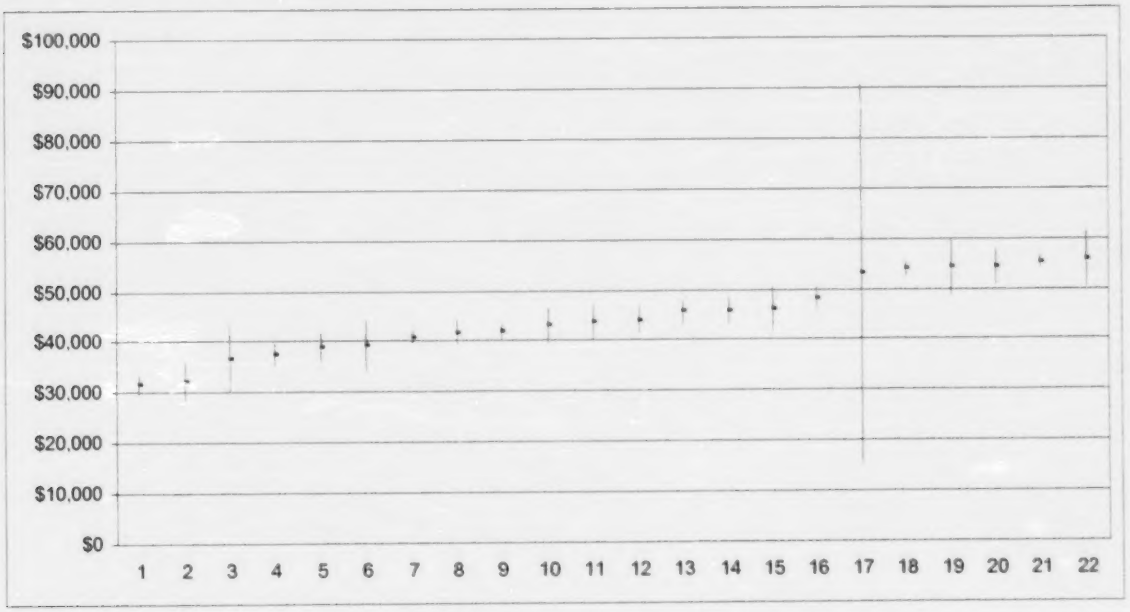
At the master's level as for the undergraduate level, we examine correlations in mean earnings across surveys as a formal method of determining whether earnings rankings are similar over time. Table 3 shows the correlation of the mean earnings of fields of studies across surveys. The correlation coefficients shown for the master's level in Table 3 are roughly similar to those given for the undergraduate level in Table 1. Thus at the master's level, as at the undergraduate level, the structure of earnings by field of study, while not identical from survey to survey, tends to persist over time.

Table 3 **Correlation in Earnings Structure by Field of Study Across Surveys: Master's Level**

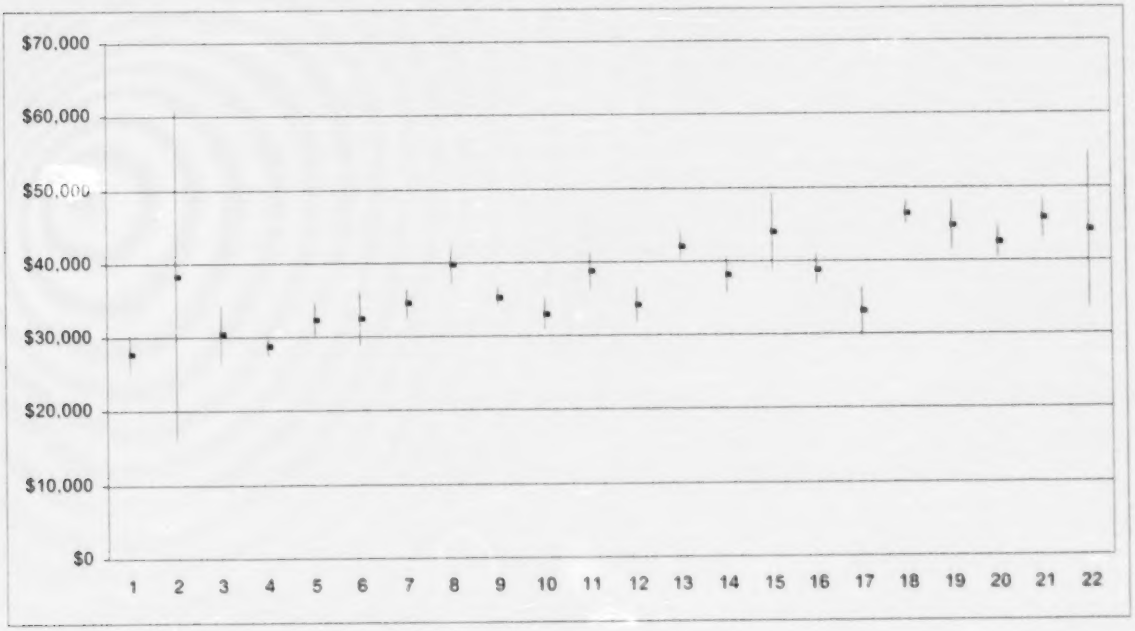
	NGS			*Follow-Up*		
	1992-1988	**1992-1984**	**1988-1984**	**1995-1991**	**1995-1987**	**1991-1987**
Ordinary	.67	.74	.81	.90	.80	.84
Rank	.76	.76	.80	.86	.81	.88
n	44			43		

Figure Series 3 **Mean Earnings by Field of Study at the Master's Level 1992, 1988 and 1984 National Graduates Survey (1992 Order)**

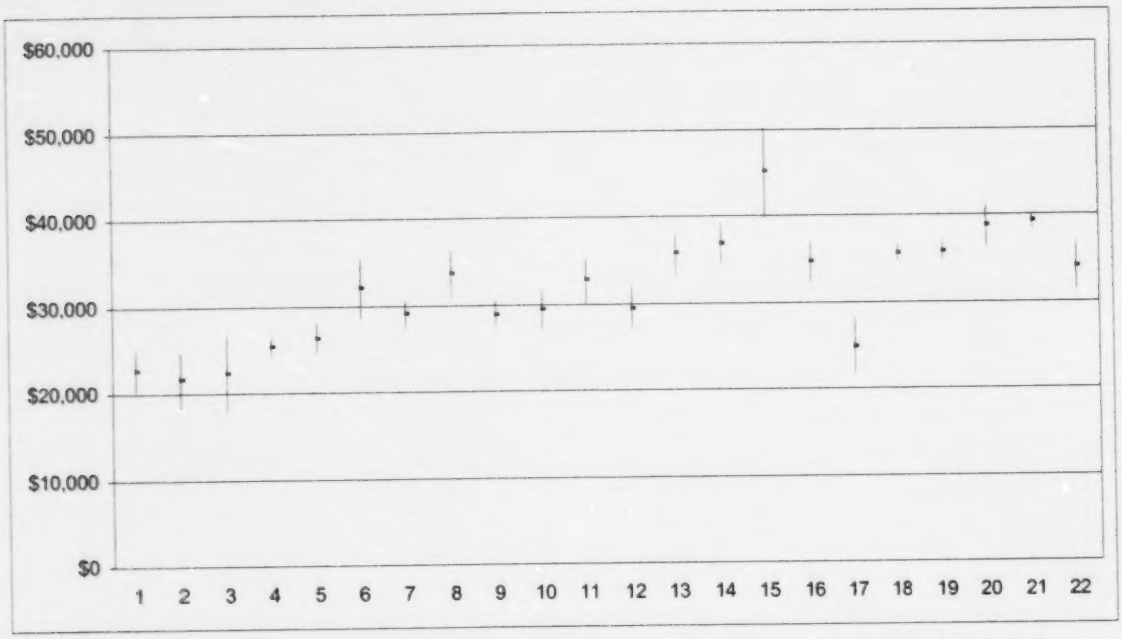
3a 1992 Earnings of 1990 Graduates



3b 1988 Earnings of 1986 Graduates



3c 1984 Earnings of 1982 Graduates



Notes: Figures 3a, 3b and 3c give the mean earnings of graduates at the Master's level by field of study in the National Graduates Surveys of 1992 (3a), 1988 (3b) and 1984 (3c). The dark point is the mean earnings for the field of study; the range indicated by the vertical line segment is plus or minus two standard errors.

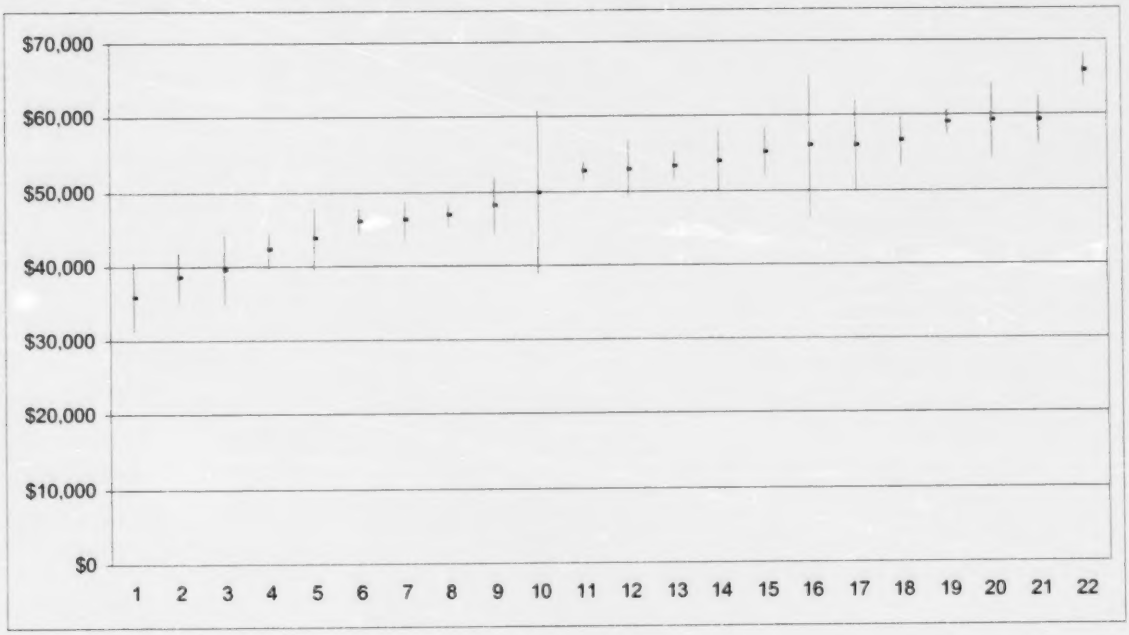
In Figures 3a, 3b and 3c the fields of study are arranged in ascending order of mean earnings in 1992 as listed below. The numbers on the horizontal axis correspond to the numbers in the list. Among the twenty-two fields of study which are shown in Figure 3, field of study 1, Biology, had the lowest mean earnings in 1995 and field of study 22, Teaching (except Elementary/Secondary and Physical Education), had the highest mean earnings in 1995.

Fields of Study in Figure Series 3 by Earnings Rank in 1992 (Ascending Order)

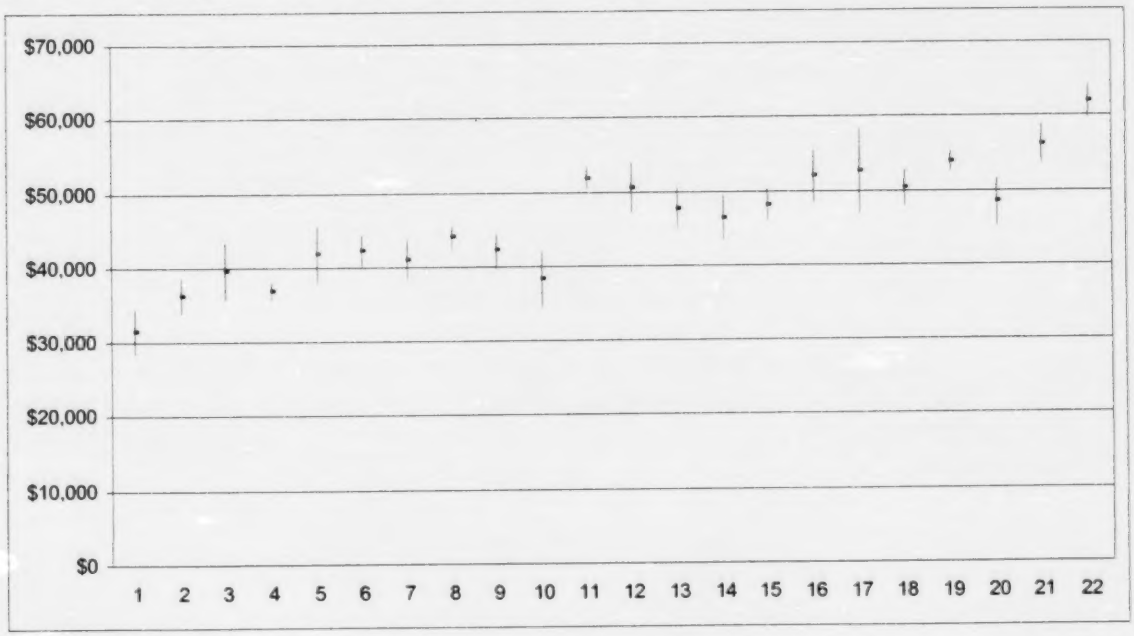
1. Biology
2. Religion/Theology
3. English
4. Library and Records Science
5. Psychology
6. Political Science
7. Rehabilitation Medicine
8. Computer Science
9. Social Work and Social Welfare
10. Planning and Resource Management
11. Civil Engineering
12. Economics
13. Electrical Engineering
14. Other Engineering
15. Other Health
16. Nursing
17. History
18. Commerce
19. Elementary/Secondary Teacher Training
20. Specialized Administration
21. Education, Non-Teaching
22. Teaching (except Elementary/Secondary and Physical Education)

Figure Series 4 Mean Earnings by Field of Study at the Master's Level 1995, 1991 and 1987 Follow-Up Survey (1995 Order)

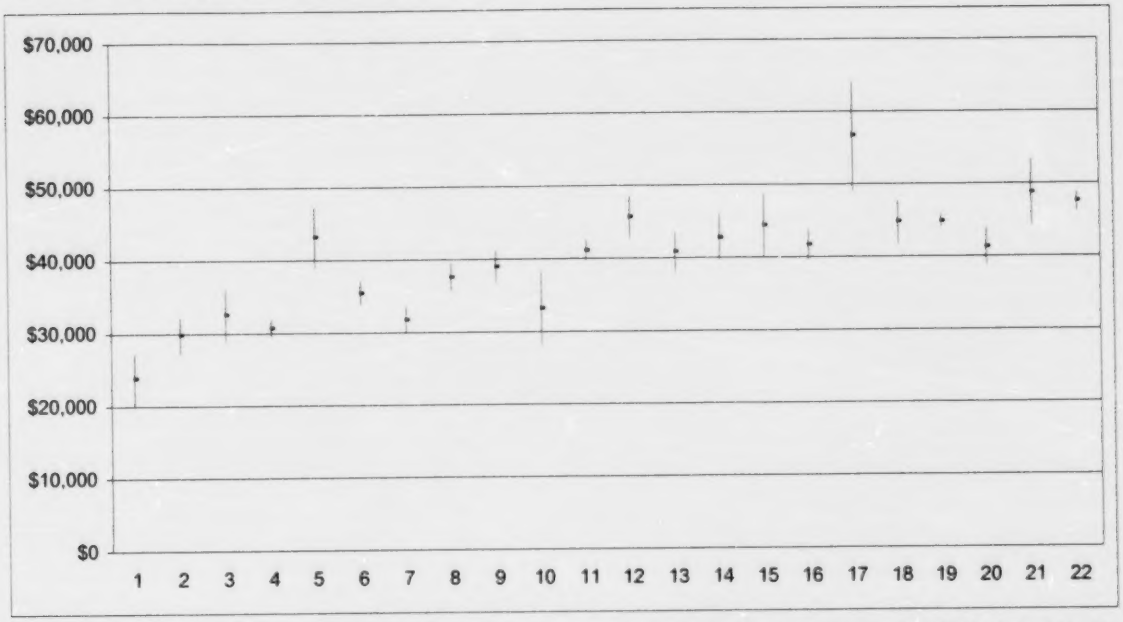
4a 1995 Earnings of 1990 Graduates



4b 1991 Earnings of 1986 Graduates



4c 1987 Earnings of 1982 Graduates



Notes: Figures 4a, 4b and 4c give the mean earnings of graduates at the undergraduate level by field of study in the Follow-Up Surveys of 1995 (4a), 1991 (4b) and 1987 (4c). The dark point is the mean earnings for the field of study; the range indicated by the vertical line segment is plus or minus two standard errors.

In Figures 4a, 4b and 4c the fields of study are arranged in ascending order of mean earnings in 1995 as listed below. The numbers on the horizontal axis correspond to the numbers in the list. Among the twenty-two fields of study which are shown in Figure 4, field of study 1, Religion/Theology, had the lowest mean earnings in 1995 and field of study 22, Commerce, had the highest mean earnings in 1995.

Fields of Study in Figure Series 4 by Earnings Rank in 1995 (Ascending Order)

1. Religion/Theology
2. Biology
3. Other Biological Sciences
4. Library and Records Science
5. Political Science
6. Rehabilitation Medicine
7. Psychology
8. Social Work and Social Welfare
9. Planning and Resource Management
10. English
11. Elementary/Secondary Teacher Training
12. Other Engineering
13. Nursing
14. Economics
15. Computer Science
16. Civil Engineering
17. Other Health
18. Electrical Engineering
19. Education, Non-Teaching
20. Teaching (except Elementary/Secondary and Physical Education)
21. Specialized Administration
22. Commerce

Earnings Structure

Table 4 shows the results of multiple comparison analysis for mean earnings by field of study at the master's level. The conventions used to construct Table 4 are identical to those used to used to construct Table 2. A horizontal line divides Table 4 into an earnings structure of two broad groups—a high earnings group and a low earnings group. For the most part, fields of study in the upper earnings group in Table 4 were in the first four broad groups in Table 2, although this is not universally true.

Table 4 Earnings Group of Fields Study: Master's Level

Field of Study	NGS			Follow-Up		
	1992 group	1988 group	1984 group	1995 group	1991 group	1987 group
Commerce	1/2	1/2	2/4	1/2	2/4	1/4
Teaching, except Elementary/Secondary	1/2	1/2	1/4	1/2	2,3/4	2/4
Specialized Administration	1/2	1,2/2	1/4	1/2	2/4	1/4
Education, Non-Teaching	1/2	1/2	1/4	1/2	2/4	2/4
Electrical Engineering	1,2/2	1,2/2	2/4	1/2	2,3/4	2/4
Civil Engineering	1,2/2	1,2/2	2/4	1/2	2/4	2/4
Other Health	1,2/2	1,2/2	1/4	1/2	2/4	1/4
Computer Science	2/2	1,2/2	2/4	1/2	3/4	2/4
Geology	2/2	2/2		1/2	3/4	
Nursing	1,2/2	1,2/2	2/4	1/2	3/4	2/4
Other Engineering	1,2/2	2/2	1/4	1/2	2/4	2/4
Economics	1,2/2	2/2	2/4	1/2	3/4	2/4
Elementary/Secondary Teaching	1/2	1/2	2/4	1/2	2/4	2/4
Mechanical Engineering	1/2	2/2		1/2	2/4	
Physics	2/2			2/2		
No Specialization	1,2/2	2/2		2/2	3,4/4	
English	2/2	2/2	3,4/4	2/2	4/4	3/4
Planning and Resource Management	2/2	2/2	2/4	2/2	3,4/4	2,3/4
Social Work/Welfare	2/2	2/2	3/4	2/2	3/4	2,3/4
Mathematics	1,2/2		2/4	2/2		
Rehabilitation Medicine	2/2	2/2	3/4	2/2	3,4/4	3/4
Psychology	2/2	2/2	3,4/4	2/2	3,4/4	3/4
Political Science	2/2	2/2	2/4	2/2	3,4/4	2/4
Chemistry	2/2			2/2		
Sociology	2/2			2/2	3,4/4	
Library/Records Science	2/2	2/2	3,4/4	2/2	4/4	3,4/4
Agriculture, except Animal/Plant Science	2/2			2/2		
Biological Sciences, except Agriculture/Biology	2/2			2/2	3,4/4	3/4
Animal/Plant Science	2/2			2/2		
Biology	2/2	2/2	3,4/4	2/2	4/4	3,4/4
History	1,2/2	2/2	3,4/4	2/2	3,4/4	
Religion/Theology	2/2	2/2	4/4	2/2	4/4	4/4

Notes: In each NGS and Follow-Up Survey shown in Table 4, every field of study shown belongs to either one or two groups of fields of studies. These groups are constructed using the procedure described in Appendix C. The lowest numbers are the highest earnings groups; the highest numbers the lowest earnings group. In 1992, the 1/2 for Commerce indicates that it is in the higher of two earnings groups, while the 1,2/2 for Electrical Engineering indicates that it is in both the first and second of the two earnings groups. The horizontal lines divide fields of which seem to fall in about the same earnings ranking across the six surveys.

The ordering of fields of study in Table 4 shows some interesting differences between the undergraduate and master's levels. Commerce and Specialized Administration are in the middle of the earnings rankings at the undergraduate level, close to Economics. At the master's level, Commerce and Specialized Administration are at the top of the earnings rankings, while Economics remains in the middle.

To examine more formally the similarity of the structure of earnings by field of study at the undergraduate and master's levels, we once again use correlation analysis. Table 5 shows the correlations for fields of study between their mean earnings at the undergraduate level and their mean earnings at the master's level. While statistically significant, most of these correlation coefficients are not particularly high. Thus the earnings structure for fields of study at the undergraduate level and the master's levels are related, but are far from identical.

Table 5 **Correlation in Earnings by Field of Study between Undergraduate and Master's Levels**

	1990 Graduates		*1986 Graduates*		*1982 Graduates*	
	1992	**1995**	**1988**	**1991**	**1984**	**1987**
Ordinary	.54	.66	.46	.90	.63	.71
Rank	.64	.57	.71	.70	.73	.60
n	36	33	37	37	38	32

3.3 Gender and the Structure of Earnings by Field of Study

Both Finnie (1999) and Côté and Sweetman (1998) estimate their models of earnings separately for women and men. While Wannell and Caron (1994) estimate a grouped earnings model, they include a complete set of interactions of gender and their explanatory variables.

Table 6 below indicates that it would indeed be desirable to compare the detailed earnings structure by field of study for women with that of men, rather than limiting ourselves to comparisons which group women with men. Our ability to make these comparisons is limited, however, by the fact that there are not a large number of fields of study with sufficient sample size for both women and men.

Table 6 reports the results of estimation of an analysis of variable model of individual earnings for a series of samples. The explanatory variables in this model are detailed field of study, gender and an interaction term between gender and field of study. Gender makes a statistically

significant contribution to the variance of earnings in each of these estimations; the interaction term also makes a statistically significant contribution to variance. In other words, the statistically significant effects of gender on earnings are not exhausted by a uniform gender effect (of lower earnings for women). The varying effects of gender in different fields of study are also statistically significant.

The fact that there are statistically significant effects on earnings of gender and of gender-field of study interactions does not necessarily mean that the ranking of fields of study by earnings differs significantly between women and men. There is only a small number of fields of study with large numbers of both female and male graduates in the NGS. This makes it difficult to characterize the extent to which the structure of earnings by field of study is similar for women and men.

Table 6 **Analysis of Variance Model of Earnings**

		Significance Level (Type I Sum of Squares)			R^2	n
		Field of Study	*Gender*	*Interaction*		
Undergraduate Level						
NGS	1992	.0001	.02	.99	.07	5219
	1988	.0001	.0001	.0001	.08	5777
	1984	.0001	.0001	.0001	.24	5417
Follow-Up	1995	.0001	.0001	.007	.27	4029
	1991	.0001	.0001	.0001	.28	5378
	1987	.0001	.0001	.0002	.34	3635
Master's Level						
NGS	1992	.0001	.0001	.01	.09	3356
	1988	.0001	.0001	.0001	.09	2734
	1984	.0001	.0001	.28	.25	2427
Follow-Up	1995	.0001	.0001	.32	.27	2830
	1991	.0001	.0001	.0001	.28	2716
	1987	.0001	.0001	.0001	.34	2141

In general, if one limits the comparison to the relatively small number of detailed fields of study whose graduates include relatively large numbers of both women and men, the earnings rankings for women and men are very similar. If one increases the number of fields of study by relaxing sample size restrictions, there appears to be more difference between men and women in the earnings structure by field of study.

Table 7 below reports correlations between average earnings of men and average earnings of women in detailed fields of study for a series of samples. In Table 7, the required sample size of women and men for a field of study is relatively small, so that the correlations are computed on the basis of a relatively large number of fields of study. The correlation coefficients reported in Table 7 are statistically significant at the 5% level in all but two cases (the ordinary (Pearson) correlation coefficients at the master's level in 1992 and in 1988.) These statistically significant, but relatively low, correlations seem to indicate that women's and men's structures of earnings by field of study, while related, are far from identical.

Table 7 Correlation of Earnings by Field of Study Between Women and Men

		NGS			*Follow-Up*		
		1992	**1988**	**1984**	**1995**	**1991**	**1987**
Undergraduate							
	Ordinary	.86	.56	.69	.89	.80	.82
	Rank	.83	.46	.57	.68	.76	.46
	n	40	35	31	34	33	28
Master's							
	Ordinary	.31	.36	.86	.76	.48	.78
	Rank	.51	.52	.91	.73	.75	.79
	n	29	21	20	25	24	17

Table 8 shows, for women and for men, groupings of fields of study in which the hypothesis of equality of means cannot be rejected. To avoid excessively large standard errors (which make it difficult to reject the null hypothesis of equality), a more restrictive sample size criterion is applied in Table 8 than in Table 7. (Appendix A gives the detail of all sample restrictions.) Table 8a shows the earnings structure by field of study for male and female graduates at the undergraduate level; Table 8b shows the earnings structure at the master's level.

At the undergraduate level, there are twenty fields of study in the 1995 Follow-Up with sufficient sample size for women and nineteen for men. There are only twelve fields of study with sufficient sample size for both genders. The fields of study with sufficient sample size for one gender, but not the other, are of some interest. There are four engineering fields of study with sufficient sample size for men, but not for women. The other three fields of study, which are reported for men only, are Economics, History and Geography. The fields of study which have sufficient sample size for women but not for men, are Pharmacy, Nursing, Rehabilitation Medicine, Food and Household Science, Social Work and Social Welfare, English, French and Other Teaching.

In the 1995 Follow-Up at the undergraduate level, the first field of study group for both women and men contains only one field of study—medicine. The second group is also small in both cases. For men, it consists of Law only; for women, it consists of Law, Pharmacy and Computer Science. There are two more groups for both women and men. Table 8a shows that all twelve fields of study with sufficient sample size for women and men are in the same group for both women and men (although they may be in another group as well). For example Sociology is in the fourth (lowest earnings) group for both women and men, but is also in the third group for men.

Table 8a **Field of Study Group by Gender: 1990 Graduates, Undergraduate Level**

Field of Study	*1992 Group*		*1995 Group*	
	Women	Men	Women	Men
Pharmacy	1/2	--	2/4	--
Medicine	1/2	1/2	1/4	1/4
Nursing	1,2/2	--	3/4	--
Law	1,2/2	1/2	2/4	2/4
Computer Science	1,2/2	1/2	2,3/4	3/4
Elementary/Secondary Teaching	1,2/2	1/2	3,4/4	3,4/4
Rehabilitation Medicine	1,2/2	--	3/4	--
Commerce	1,2/2	2/2	3,4/4	3,4/4
Social Work/Social Welfare	1,2/2	--	3,4/4	--
Specialized Administration	1,2/2	--	--	--
No Specialization	1,2/2	2/2	3/4	3,4/4
Mathematics	1,2/2	1/2	3/4	3/4
Other Teaching	1/2	--	4/4	--
Sociology	2/2	2/2	4/4	3,4/4
French	2/2	--	4/4	--
Food/Household Sciences	2/2	--	4/4	--
Political Science	2/2	2/2	3,4/4	4/4
Physical Education	2/2	2/2	4/4	3,4/4
English	2/2	2/2	4/4	--
Biology	2/2	2/2	4/4	4/4
Psychology	2/2	2/2	4/4	3,4/4
Chemistry	2/2	2/2	--	--
Biological Sciences, except Agriculture and Biology	2/2	2/2	--	--
Chemical Engineering	--	1/2	--	--
Electrical Engineering	--	1/2	--	3/4
Civil Engineering	--	1/2	--	3/4
Other Engineering	--	1/2	--	3/4
Mechanical Engineering	--	1/2	--	3/4
Religion/Theology	--	2/2	--	--
Economics	--	2/2	--	3,4/4
Geography	--	2/2	--	4/4
History	--	2/2	--	3,4/4

Table 8b Field of Study Group by Gender: 1990 Graduates, Master's Level

Field of Study	*1992 Group*		*1995 Group*	
	Women	Men	Women	Men
Specialized Administration	1/2	1/3	1/2	1/3
Elementary/Secondary Teaching	1/2	1/3	1/2	1,2/3
Education, non-Teaching	1/2	1/3	1/2	1,2/3
Nursing	1/2	--	1/2	--
Other Health	1/2	--	1/2	--
Commerce	1/2	1/3	1/2	1/3
Planning/Resource Management	1,2/2	2,3/3	--	2,3/3
Social Work/Social Welfare	1,2/2	2/3	2/2	2/3
Rehabilitation Medicine	1,2/2	--	2/2	--
Psychology	1,2/2	2,3/3	2/2	2,3/3
Sociology	1,2/2	--	2/2	--
Library/Records Sciences	1,2/2	--	2/2	--
Biology	2/2	2,3/3	2/2	--
Mechanical Engineering	--	1/3	--	2/3
Civil Engineering	--	1/3	--	1,2/3
Other Engineering	--	1/3	--	1,2/3
Electrical Engineering	--	1,2/3	--	1,2/3
Economics	--	1,2/3	--	1,2/3
Computer Science	--	2/3	--	1,2/3
No Specialization	--	2,3/3	--	--
Geology	--	2,3/3	--	1,2/3
Physics	--	2,3/3	--	--
Religion/Theology	--	3/3	--	3/3

Notes: In the 1992 NGS and the 1995 Follow-Up Survey, every field of study shown for women or for men belongs to either one or two groups of fields of studies. These groups are constructed using the procedure described in Appendix C. The lowest numbers are the highest earnings groups; the highest numbers the lowest earnings group. For women at the undergraduate level (Table 8a) in 1992, the 1/2 for Pharmacy indicates that it is in the first of the two earnings groups, while the 1,2/2 for Commerce indicates that it is in both the first and the second of the two earnings groups.

In the 1992 NGS at the undergraduate level, women and men each have three more fields of study with sufficient sample size to be reported than in the 1995 Follow-Up. Only one of these, Chemistry, has sufficient sample size for both women and men. In the 1992 NGS, for both women and men, two field of study groups suffice to divide the reported fields of study into groups in which one cannot reject the hypothesis of equality of mean earnings. As in the 1995 Follow-Up, the fields of study which can be reported for both women and men are in the same group for both genders (although they may be in another group as well).

At the master's level, there are even smaller numbers of fields of study that meet the sample size criteria for reporting. In the 1995 Follow-Up, there are fifteen fields of study for men, twelve for women, and six for both men and women. Once again, many of the fields of study which can be reported for men, but not for women, are in engineering, and many of those which can be reported for women, but not for men, are in health professions. The six fields of study which can be reported for both women and men once again lie in the same group of fields of study in the earnings structure for both genders.

In the 1992 NGS at the master's level, a slightly larger number of fields of study can be reported than in 1995. There are eight fields of study which can be reported for both genders. Once again, these fields of study are in the same group in the earnings structure for both women and men.[10]

To sum up, if as in Table 8, one restricts oneself to fields of study in which there are large numbers of both women and men in the NGS and Follow-Up samples, the structure of earnings by field of study appears quite similar for women and men.[11] If one eases the sample size restriction, as in Table 7, the earnings structures of the two genders appear to be less closely related (although still significantly related). This may simply be due to greater variance resulting from a smaller sample size in some fields of study. It also may be the case that fields of study in which one gender is sparsely represented differ more in their earnings ranks for women and men than those with significant representation of both genders.

3.4 Earnings Structure: Summary

In our opinion, there is an earnings structure by field of study in the sense that we have defined an earnings structure: groupings of fields of study with statistically significant differences between average earnings in the fields of study in different groups and groupings that are reasonably stable over time. This does not mean that there is an unchanging hierarchy of

[10] In both 1992 and 1995, there are two fields of study groups for women at the master's level, and three for men. In both years, there would only be two groups for men if the lowest earnings group, Religion and Theology, were eliminated. Thus the structure of earnings for the two genders is more similar than might appear at first glance in the fields of study in which they are both present.

[11] This impression is confirmed by correlations using the stricter sample size criterion.

earnings by field of study, with average earnings in each field of study significantly different from average earnings in every other field of study.

There is often considerable overlap between the field of study groups we defined on the basis of average earnings. The earnings rank of a field of study may vary considerably between two of the surveys continued. In short, the boundaries between the groups are ill-defined and shifting. Fields of study towards the bottom of the earnings distribution remain towards the bottom; and fields of study towards the top remain towards the top. This impression is confirmed by the high correlation of the earnings rank of fields of study between surveys.

The earnings structures at the master's level and at the undergraduate level have both similarities and differences. To cite one striking difference, undergraduate level Commerce graduates are in the upper middle of the undergraduate level earnings structure, while master's level Commerce graduates are at or near the top of the master's level earnings structure. The similarities in the undergraduate level and master's level earnings structures are shown by the statistically significant correlation between the earnings rank of fields of study at these levels.

Finally, there are statistically significant differences between the earnings of women and men at both the undergraduate and master's level, beyond the differences due to differing field of study distributions. Sample size considerations make it difficult to evaluate the degree of similarity between the earnings structure for women and the structure for men. If one limits oneself to the small number of fields of study where there are significant numbers of both women and men, the earnings structures appear very similar. If one compares a broader range of fields of study, there appears to be a broader range of difference (although this may simply result from higher standard errors of means due to smaller sample size in the additional fields of study). There is certainly a strong relation between the earnings rank for women and men of fields of study where both are present, but it is difficult to specify exactly how strong this relation is.

4. Similarity of Occupational Distributions

This section examines the occupational distribution of graduates by field of study with the goal of identifying fields of study with similar occupational distributions of their graduates. When we are able to identify similarities, we will seek to relate them to the structure of earnings by field of study. We consider the occupational distributions of only the most recent cohort of graduates for which both the NGS and Follow-Up Survey are available, that is, 1990 graduates. Within these cohorts, only graduates who were employed full-time as of the survey are included in our samples (see Appendix A for further details on sample selection criteria).

What is aimed at here is essentially a descriptive analysis of the similarity of occupational distributions of graduates in various fields of study. To develop this description, we used cluster analysis to group fields of study on the basis of similarities in the occupational distributions of graduates. At the start of the process, each field of study constitutes a cluster. The process of grouping fields of study into clusters continues until all fields of study are grouped into one cluster. The clustering levels we report were chosen on the basis of diagnostic measures furnished by the cluster analysis program and of our judgement as to the most useful grouping.

The occupational classification used in this analysis is based on the 1980 Standard Occupational Classification (SOC). Unit group (4-digit) SOC codes were available on our data files. We drew on earlier work (Boothby, 1999) to assign these occupations either to the group of occupations that require a post-secondary education or to one of four groups of occupations that do not require a post-secondary education. (These four groups are data manipulation (essentially clerical) occupations, personal service occupations, skilled goods production occupations and other goods production occupations.)

The occupations used in the cluster analysis were 3-digit (minor group) SOC occupations when the 4-digit SOC occupation requires a post-secondary education or one of the four occupational groups that do not require a post-secondary education when the 4-digit SOC occupation was part of this group. For example, a graduate working as a physician (SOC 3111) is assigned to the 3-digit SOC occupation 311 (Health Diagnosis and Treating Occupations). A graduate working as secretary (SOC 4111) is assigned to the data manipulation category of non-post secondary

occupations. The input data to the cluster analysis for each field of study is the occupational distribution of its graduates in the occupational classification structure we have just described.

4.1 Undergraduate Level

Table 9 gives the results of the cluster analysis for the 1992 and 1995 jobs of 1990 graduates at the undergraduate level. By using ten clusters for 1992 and eleven clusters for 1995, very similar groupings are obtained. There are only five differences between the 1992 and 1995 clusters, four of which concern fields of study which are in the General cluster in 1992. Religion/Theology moves into its own cluster in 1995; Planning and Resource Management and Physics move into the Engineering cluster in 1995; and Forestry is dropped from the analysis in 1995, due to insufficient sample size. The fifth change is that Mathematics moves from the Computer Science cluster in 1992 to the General cluster in 1995, although in both years the largest number of Mathematics graduates works in Mathematics, Statistics and Systems Analysis occupations (over 40% in both years).

Table 9 also gives the occupations with 10% or more of graduates in each field of study for 1992 and 1995. The four non-post-secondary occupational categories of occupations are combined into a single category in Table 9 (but not in the cluster analysis used to construct the table).

There is a sharp contrast in Table 9 between the General cluster and the other nine clusters. Each of the other clusters is based on a high percentage of graduates in the programs in the cluster who work in a single 3-digit occupation which is directly related to their program. To enumerate: health diagnosis and treating graduates work in Health Diagnosis and Treating occupations, Engineering graduates work in Architectural, Engineering and Community Planning occupations, Teaching graduates work as Elementary and Secondary Teachers, Health Treatment graduates work in Nursing and Therapy occupations, Computer Science and Mathematics graduates work in Mathematics, Statistics and Systems Analysis occupations, graduates in Linguistics, Translation and Interpretation and in Journalism work as writers, Social Work graduates work in Social Work occupations, Law graduates work as lawyers, and Pharmacy graduates work in Other Occupations in Medicine and Health (which includes Pharmacists).

Table 9 **Field of Study Clusters and Principal Occupational Groups in Fields of Study: Undergraduate Level**

Field of Study	*Occupation*	*% of employment* 1992	1995
Health Diagnosis & Treating			
Veterinary Medicine	Health Diagnosis and Treating (311)	95	95
Dentistry	Health Diagnosis and Treating (311)	98	100
Medicine	Health Diagnosis and Treating (311)	96	95
Engineering			
Architecture	Non-post-secondary occupations	18	13
	Managers (outside government) (113/114)	13	13
	Architects, Engineers and Community Planners (214)	20	24
	Other Occupations in Architecture and Engineering (216)	50	37
Chemical Engineering	Non-post-secondary occupations	13	13
	Architects, Engineers and Community Planners (214)	53	41
Civil Engineering	Non-post-secondary occupations	14	15
	Architects, Engineers and Community Planners (214)	59	49
	Managers (outside government) (113/114)	--	15
Electrical Engineering	Non-post-secondary occupations	13	14
	Architects, Engineers and Community Planners (214)	44	42
	Mathematics, Statistics, Systems Analysis, etc. (216)	26	27
Mechanical Engineering	Non-post-secondary occupations	13	16
	Architects, Engineers and Community Planners (214)	58	53
Other Engineering	Non-post-secondary occupations	12	--
	Architects, Engineers and Community Planners (214)	57	53
Other Applied Science	Non-post-secondary occupations	11	19
	Architects, Engineers and Community Planners (214)	69	68
Teaching			
Elementary/Secondary Teaching	Elementary/Secondary Teaching (273)	88	83
Other Teaching	Elementary/Secondary Teaching (273)	66	65
Education, non-Teaching	Elementary/Secondary Teaching (273)	67	74
	Other Teaching and Related (279)	12	12
	Managers (outside government) (113/114)	10	--
Health Treatment			
Nursing	Nursing, Therapy, etc. (313)	77	73
Rehabilitation Medicine	Nursing, Therapy, etc. (313)	96	98

Table 9 (continued)

Field of Study	*Occupation*	*% of employment* 1992	1995
Computer Science and Mathematics			
Computer Science	Mathematics, Statistics, Systems Analysis, etc. (216)	77	78
Mathematics *(General Cluster in 1995)*	Non-post-secondary occupations	22	19
	Mathematics, Statistics, Systems Analysis, etc. (216)	44	41
	Management-related (117)	11	21
Writing			
Linguistics, Translation and Interpretation	Non-post-secondary occupations	14	--
	Writing (335)	55	63
	Managers (outside government) (113/114)	18	22
Journalism	Writing (335)	92	74
	Managers (outside government) (113/114)	--	18
Social Work			
Social Work and Social Welfare	Social Work (233)	80	82
Law			
Law	Non-post-secondary occupations	13	13
	Lawyers, etc. (234)	79	77
Pharmacy			
Pharmacy	Other Occupations in Medicine and Health (315)	93	92
General			
No Specialization	Non-post-secondary	31	34
	Managers (outside government) (113/114)	11	11
	Mathematics, Statistics, Systems Analysis, etc. (218)	10	11
	Elementary/Secondary Teaching	17	18
Physical Education	Non-post-secondary occupations	18	26
	Elementary/Secondary Teaching	16	18
	Management (outside government) (113/114)	17	15
	Management-related (117)	13	--
	Social Work (233)	13	--
	Nursing, Therapy, etc. (313)	--	11
Music	Non-post-secondary occupations	31	41
	Performing Arts (333)	22	21
	Elementary/Secondary Teaching (273)	23	31

Table 9 (continued)

Field of Study	*Occupation*	*% of employment* 1992	1995
Fine and Performing Arts (except Music)	Non-post-secondary occupations	48	43
	Elementary/Secondary Teaching (273)	15	11
	Fine and Commercial Art (331)	--	11
Applied Arts	Non-post-secondary occupations	35	24
	Fine and Commercial Art (331)	40	42
	Managers (outside government) (113/114)	11	--
English	Non-post-secondary occupations	42	35
	Elementary/Secondary Teaching	16	17
	Managers (outside government) (113/114)	--	18
	Writing (335)	--	10
French	Non-post-secondary occupations	27	22
	Elementary/Secondary Teaching	30	28
	Managers (outside government) (113/114)	--	13
	Management-related (117)	12	--
	Writing (335)	--	10
History	Non-post-secondary occupations	50	33
	Managers (outside government) (113/114)	12	10
	Management-related (117)	15	--
	Elementary/Secondary Teacher (273)	--	11
	Social Work (233)	--	10
	Fine and Commercial Arts (331)	--	10
Classical and Other Languages	Non-post-secondary occupations	33	35
	Managers in Government (111)	12	15
	Managers (outside government) (113/114)	28	15
	Management-related (117)	--	12
	Sales Supervisors (selected 513)	--	15
Mass Communications (except Journalism)	Non-post-secondary occupations	50	31
	Management-related (117)	10	13
	Fine and Commercial Art (331)	22	--
	Performing Arts (333)	--	19
Philosophy	Non-post-secondary occupations	51	45
	Mathematics, Statistics, Systems Analysis, etc. (218)	21	34
	Sales Supervisors (selected 513)	10	17
	Managers (outside government) (113/114)	10	--

Table 9 (continued)

Field of Study	*Occupation*	*% of employment*	
		1992	1995
Religion and Theology *(Separate Cluster in 1995)*	Non-post-secondary occupations	13	11
	Religion (251)	45	55
	Elementary/Secondary Teaching (273)	14	18
	Managers (outside government) (113/114)	15	--
Area Studies	Non-post-secondary occupations	45	na
	Management-related (117)	18	na
	Elementary/Secondary Teaching (273)	21	na
Commerce	Non-post-secondary occupations	28	25
	Managers (outside government) (113/114)	19	26
	Management-related	41	37
Specialized Administration	Non-post-secondary occupations	42	36
	Managers in government (111)	--	16
	Managers (outside government) (113/114)	41	22
	Management-related (117)	--	18
Economics	Non-post-secondary occupations	39	34
	Managers (outside government) (113/114)	23	26
	Management-related (117)	20	27
Geography	Non-post-secondary occupations	39	42
	Management-related (117)	16	--
	Architects, Engineers and Community Planners (214)	--	11
Planning and Resource Management *(Engineering Cluster in 1995)*	Non-post-secondary Occupations	28	30
	Managers (outside government) (113/114)	17	29
	Architects, Engineers and Community Planners (214)	20	25
	Non-post-secondary occupations	47	40
	Managers (outside government)	23	19
	Management-related (117)	13	17

The results of the cluster analysis in fact understate the occupational specificity of the fields of study in these nine clusters. When a 4-digit level of occupational detail is used, these clusters tend to break up, with the different fields of study in the cluster feeding different 4-digit components of the 3-digit occupations. Thus within the Health Diagnosis and Treating fields of study, graduates in Medicine work as Physicians and Surgeons, graduates in Dentistry work as Dentists, and graduates in Veterinary Medicine work as Veterinarians. Similarly, in the Health Treatment cluster, Nursing graduates work as Nurses, and Rehabilitation Medicine graduates work as Physiotherapists or Occupational Therapists (presumably depending on which they studied). Finally, the Writing cluster breaks up between the graduates in Linguistics, Translation

and Interpretation, who work as Translators and Interpreters, and the graduates in Journalism, who work as writers.

The situation in the General cluster is very different. The common ground among fields of study in this cluster is the high proportion of their graduates who work in occupations for which a post-secondary education is not normally required. Other occupations in which graduates in these fields of study often work are non-governmental managerial occupations and elementary and secondary teaching.[12]

Beyond this common ground, there is often evidence of occupational specificity within fields of study. For example, although 34% of 1990 graduates in Applied Arts worked in occupations which do not normally require a post-secondary education in 1992, another 40% worked in Occupations in Fine and Commercial Arts. Similarly, while 41% of 1990 graduates in Food and Household Sciences worked in non-post-secondary occupations in 1992, 31% worked in Other Occupations in Medicine and Health (which includes Dieticians and Nutritionists).

With some exceptions, the occupationally specific fields of study in the first nine clusters are professional programs, while the fields of study in the General cluster are in Arts, Humanities, Social Sciences and Business. In the first nine clusters, there are fields of study (for example, Mathematics) where more than 10% of graduates work in non-post-secondary occupations. The percentage of graduates in a field of study working in non-post-secondary occupations tends to be much higher in fields of study in the General cluster than in fields of study outside this cluster.

For the occupationally specific fields of study in the first nine clusters, earnings levels of graduates will be closely tied to earnings levels in the specific occupations these graduates enter. For example, graduates in Journalism will earn less than graduates in Dentistry because dentists earn more than writers. With one exception, the Writing cluster, graduates in the fields of study in the nine occupationally specific clusters earn more than graduates in the General cluster.

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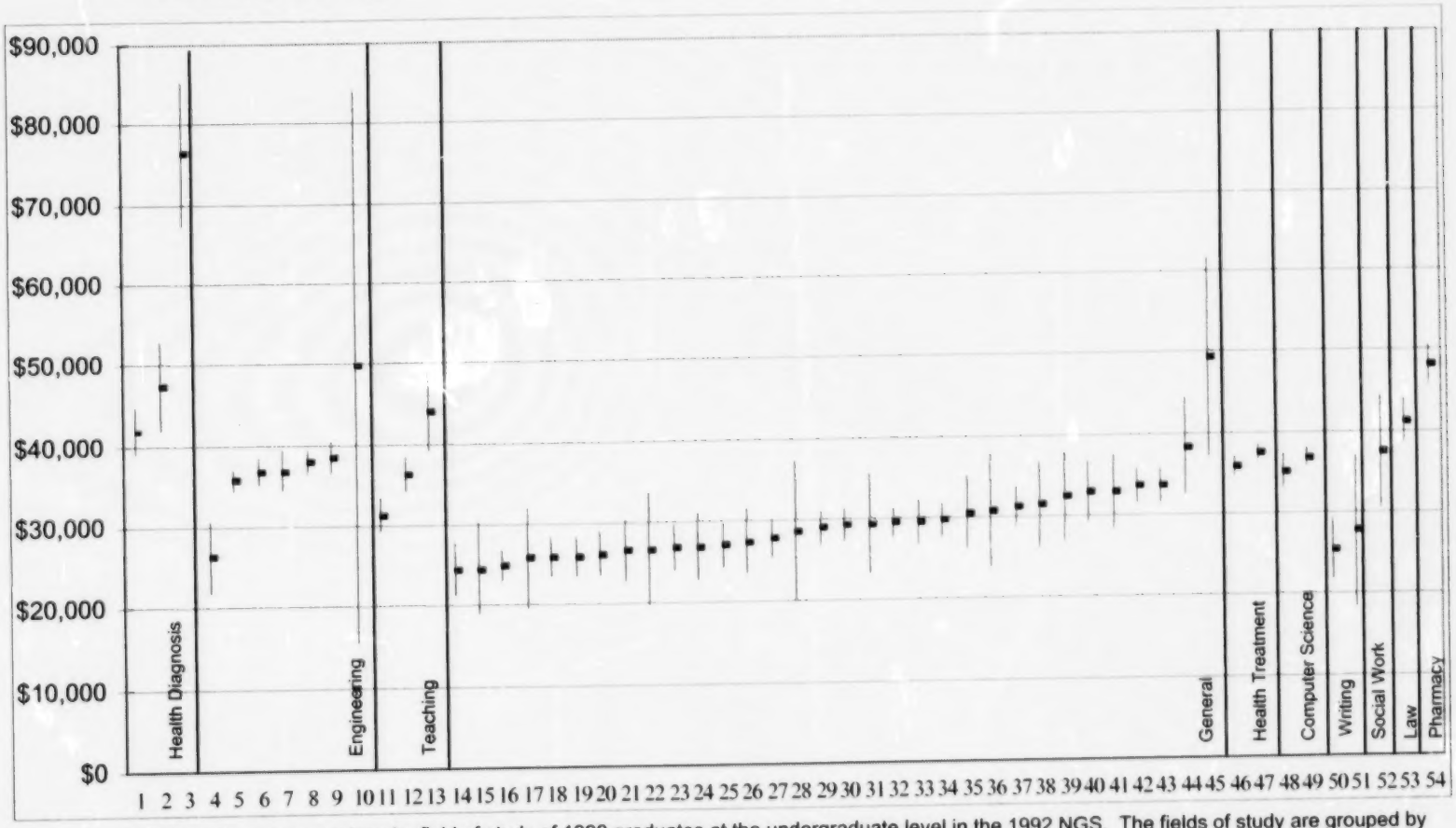
[12] One might wonder how, for example, an English graduate is able to work as an elementary or secondary teacher. It should be noted that while we have excluded graduates who acquire further qualifications beyond those which lead to their inclusion in the sample, graduates may have qualified as teachers before undertaking the program which lead to their inclusion in the sample. In short, English graduates working as teachers may have been teaching graduates before they became English graduates. We have not attempted to examine how often this is the case in our samples.

Figure 5 **Mean Earnings by Filed of Study and Occupational Cluster: Undergraduate Level, 1992 National Graduates Survey**



Notes: Figure 5 gives the mean earnings by field of study of 1990 graduates at the undergraduate level in the 1992 NGS. The fields of study are grouped by occupational cluster; within each occupational cluster the fields of study are arranged by order of mean earnings. The dark point is the level of mean earnings; the range indicated is plus or minus two standard errors. The numbers on the horizontal axis of Figure 5 correspond to the numbering of the fields of study listed below.

Figure 5 **Legend**

Health Diagnosis Cluster
1. Veterinary Sciences and Medicine
2. Medicine
3. Dentistry

Engineering Cluster
4. Architecture
5. Mechanical Engineering
6. Civil Engineering
7. Other Engineering
8. Electrical Engineering
9. Chemical Engineering
10. Landscape Architecture

Teaching Cluster
11. Teaching (other than Elementary/Secondary and Physical Education)
12. Elementary/Secondary Teacher Training
13. Education, Non-Teaching

General Cluster
14. Other Social Science
15. Classical and Other Languages
16. Biology
17. Fine and Performing Arts (except Music)
18. Animal and Plant Science
19. English
20. Geography
21. Applied Arts
22. Music
23. History
24. Mass Communication (except Journalism)
25. Chemistry
26. Other Biological Sciences
27. Food and Household Sciences
28. Agriculture (except Animal/Plant Science)
29. Physical Education
30. Sociology
31. Philosophy
32. Psychology
33. French
34. Political Science
35. Geology
36. Physics
37. Economics
38. Area Studies
39. Planning and Resource Management
40. Specialized Administration
41. Religion/Theology
42. No Specialization
43. Commerce
44. Forestry
45. Other Health

Health Treatment Cluster
46. Rehabilitation Medicine
47. Nursing

Computer Science Cluster
48. Mathematics
49. Computer Science

Writing Cluster
50. Linguistics, Translation and Interpretation
51. Journalism

Social Work Cluster
52. Social Work

Law Cluster
53. Law

Pharmacy Cluster
54. Pharmacy

Figure 5 shows the 1992 mean earnings (and plus and minus two standard errors) for 1990 graduates at the undergraduate level, sorted by cluster, and by mean earnings within the cluster. Mean earnings for fields of study in the General cluster lie between $24,000 and $34,000 except for two high earnings outliers (Forestry and Other Health). Mean earnings are at the low end of this range in the Writing cluster.

In the remaining eight clusters, mean earnings in all but two fields of study are more than $34,000. One of the exceptions, Architecture, has mean earnings of $26,300; the other, Other Teaching, has mean earnings of $31,200. Thus apart from these two exceptions and the two fields of study in the Writing Cluster, occupationally specific fields of study have higher mean earnings than the fields of study in the General cluster. Note that this characterization of earnings rankings agrees well with the rankings shown across all six surveys in Table 2.

What of earnings within the General cluster? We recall that the common ground of fields of study in this cluster is the high proportion of graduates working in jobs that do not normally require a post-secondary education. One important determinant of the earnings ranking of these

fields of study therefore might be the proportion of graduates in each field of study who work in non-post-secondary jobs. With this possibility in mind, for each field of study in the General cluster, we regressed 1992 mean earnings on the proportions of graduates in the field of study whose 1992 job was in one of the four non-post-secondary groups of occupations. The results are given in Table 10.

Table 10 **Regression of Mean Earnings in Fields of Study in General Cluster on Proportions Working in Non-Post-Secondary Occupational Groups**

	Variable	*Coefficient*	*Standard Error*
	Constant	32,800	3,267
Proportion in:	Data Manipulation*	-18,560	8,548
	Personal Services	20,767	12,950
	Skilled Goods Production	-5,349	17,780
	Other Goods Production	-19,961	17,492

Notes: Asterisk (*) significant at 5% level, R^2 = .20 (corrected for degrees of freedom), n = 32

Table 10 shows clearly that we can not account for most of the earnings differences between fields of study in the General cluster on the basis of the percentage of graduates in the various non-post-secondary categories of occupations (R^2 adjusted for degrees of freedom = .2). The only statistically significant coefficient is for data manipulation occupations. A field in the General cluster with 10% more of its graduates in data manipulation occupations than another field in the same cluster is predicted to have an average earnings level $1,856 lower than the second field.

4.2 Master's Level

A cluster analysis of the occupational distribution by field of study was also carried out for the master's level. The results are given in Table 11. The fifteen clusters shown are those of 1992. There was insufficient sample size in 1995 to include six of the fields of study shown for 1992 (Mechanical Engineering; No Specialization; English; Other Health; Linguistics, Translation and Interpretation; and Geology). Aside from these disappearances, the only difference between the 1992 clusters and the (fourteen) 1995 clusters is that Political Science moves from the Commerce cluster to its own cluster.

Table 11 **Field of Study Clusters and Principal Occupational Groups in Fields of Study: Master's Level**

Field of Study	*Occupation*	*% of employment* 1992	1995
Engineering			
Planning and Resource Management	Managers (outside government (113/114)	11	--
	Management-related (117)	14	13
	Architects, Engineers and Community Planners (214)	32	42
	University Teachers, etc. (271)	10	--
Civil Engineering	Managers (outside government (113/114)	13	11
	Architects, Engineers and Community Planners (214)	65	64
Electrical Engineering	Architects, Engineers and Community Planners (214)	43	41
	Mathematics, Statistics, Systems Analysis, etc. (218)	27	29
Mechanical Engineering	Architects, Engineers and Community Planners (214)	66	na
Other Engineering	Managers (outside government (113/114)	10	12
	Architects, Engineers and Community Planners (214)	46	42
Teaching			
No Specialization	Managers (outside government (113/114)	14	na
	Elementary/Secondary Teaching (273)	22	na
	Other Teaching (279)	14	na
Elementary/Secondary Teaching	Managers (outside government (113/114)	20	19
	Elementary/Secondary Teaching (273)	40	39
	Other Teaching (279)	17	19
Other Teaching	Managers (outside government (113/114)	14	17
	Elementary/Secondary Teaching (273)	40	50
	Other Social Science (239)	15	17
	Other Teaching (279)	23	--
Education, non-teaching	Managers (outside government (113/114)	33	31
	Elementary/Secondary Teaching (273)	41	37
	Other Teaching (279)	--	13
English	Elementary/Secondary Teaching	32	na
	Other Teaching (279)	13	na
	Writing (335)	10	na
Nursing			
Nursing	Managers (outside government (113/114)	20	24
	Other Teaching (279)	18	14
	Nursing, Therapy, etc. (313)	37	39

Table 11 (continued)

Field of Study	*Occupation*	*% of employment* 1992	1995
Rehabilitation Medicine			
Rehabilitation Medicine	Nursing, Therapy, etc. (313)	84	92
Computer Science			
Computer Science	Mathematics, Statistics and Systems Analysis (218)	76	72
	Managers (outside government (113/114)	–	11
Writing			
Linguistics, Translation and Interpretation	Elementary/Secondary Teaching (273)	14	na
	Writing (335)	65	na
Social Work			
Social Work and Social Welfare	Managers (outside government (113/114)	10	14
	Social Work (233)	70	70
Religion			
Religion/Theology	Religion (251)	61	60
Commerce			
Commerce	Managers (outside government (113/114)	35	37
	Management-related (117)	29	26
Specialized Administration	Managers (outside government (113/114)	40	41
	Management-related (117)	33	21
Political Science (Separate Cluster in 1995)	Non-post-secondary occupations	12	–
	Managers in government (111)	11	–
	Managers (outside government (113/114)	15	–
	Management-related (117)	42	20
	Social Sciences (231)	–	13
	Elementary/Secondary Teaching (273)	–	12
	Writing (335)	–	22
Social Science			
Economics	Non-post-secondary occupations	11	–
	Managers (outside government (113/114)	11	14
	Management-related (117)	12	–
	Mathematics, Statistics, Systems Analysis, etc. (218)	13	13
	Social Sciences (231)	40	40
Psychology	Social Sciences (231)	39	46

Table 11 (continued)

Field of Study	*Occupation*	*% of employment* 1992	1995
History			
History	Non-post-secondary occupations	22	11
	Library, Museum, Archival Science (235)	15	20
	Elementary/Secondary Teaching (273)	12	19
	Managers (outside government (113/114)	--	13
Sociology			
Sociology	Non-post-secondary occupations	15	13
	Managers (outside government (113/114)	19	13
	University Teaching and related (271)	--	13
Other Health	Managers (outside government (113/114)	24	na
	Management-related (117)	13	na
Library Science			
Library/Records Science	Non-post-secondary occupations	--	10
	Library, Museum, Archival Science (235)	62	61
Biology			
Biology	Non-post-secondary occupations	--	12
	Life Sciences (213)	30	33
	University Teaching and related (271)	21	21
	Other Occupations in Medicine and Health (315)	12	--
Geology			
Geology	Physical Sciences (211)	63	na
	Architecture, Engineering and Community Planning (214)	16	na

In some respects the results in Table 11 are similar to those given for the undergraduate level in Table 9; but there are important differences. The most significant is that the incidence of graduates working in non-post-secondary occupations is greatly decreased at the master's level. As a result, the General cluster disappears at the master's level.

Some of the fields of study which were in the General cluster at the undergraduate level have a fairly high degree of occupational specificity at the master's level. For example, Economics and Psychology now constitute a Social Science cluster in which 40% or more of graduates in each of these two fields work in Occupations in Social Science (which include economists and

psychologists). Commerce and Specialized Administration (along with Political Science in 1992) constitute a Commerce cluster at the master's level, in which most graduates work in managerial and management-related occupations.

Two clusters, Engineering and Teaching, survive in much the same form at the master's level as at the undergraduate level. The occupational distribution of graduates in these clusters is much the same as for the undergraduate cluster, apart from the decrease in the proportion of graduates working in non-post-secondary occupations.

Apart from the break-up of the General cluster, the 'Health Treatment' cluster also broke up into its two constituents, Nursing and Rehabilitation Medicine.[13] As at the undergraduate level, most Rehabilitation Medicine graduates work in Nursing and Therapy occupations. A significant proportion of nursing graduates at the master's level also works in this occupational group, but other nursing master's graduates work as managers and in teaching occupations.

In our view, the occupational distribution of master's levels graduates, as compared to graduates at the undergraduate level, can be summed up as follows: first, master's level graduates in general are much less likely to work in non-post-secondary occupations. Second, fields of study which were occupationally specific at the undergraduate level remain occupationally specific at the graduate level. Third, the fields of study in which many graduates at the undergraduate level worked in non-post-secondary occupations tend to be much more occupationally specific at the master's level than at the undergraduate level.

4.3 Similarity of Occupational Distributions: Summary

At the undergraduate level, we can divide fields of study into two groups—one which is occupationally specific, in that graduates in these fields of study are highly concentrated in an occupation closely related to the program of study, another which is not. In fields of study in the second group, a large proportion of graduates in 1990 worked in occupations that do not normally require post-secondary studies in both 1990 and 1995.

[13] None of the fields of study in the Health Diagnosis cluster has sufficient sample size at the master's level to be included in the cluster analysis. In both of the remaining undergraduate clusters with more than one field of study (Computer Science and Writers), one of the two fields of study in the cluster no longer has sufficient sample size at the graduate level.

Occupationally specific fields of study tend to be professional programs (although Computer Science and Mathematics are occupationally specific), while non-occupationally specific programs at the undergraduate level are concentrated in the arts, humanities, and social sciences. Earnings are usually higher in the occupationally specific fields of study, although there are some exceptions, notably Architecture and the fields of study which lead to employment in writing occupations.

At the master's level, employment of graduates in non-post-secondary occuptions is much less prevalent. Almost all fields of study seem to have a fairly strong degree of occupational specificity.

One question we have not addressed is why graduates at the undergraduate level in a broad range of fields of study are working in jobs which apparently do not require university-level studies. One possible explanation is that graduates in the 1990 cohort we considered faced a very unfavourable labour market in the first half of the 1990s. Comparisons over time could be used to assess this explanation. In particular, an examination of the occupational distribution of 1995 graduates in the 1997 NGS might shed light on this issue. Other possible explanations include: 1) upgrading of skills requirements in the occupations we have labeled as not requiring a post-secondary education, has lead employers to hire university graduates for these positions; and 2) trend growth in the supply of graduates in these fields of study has outstripped trend growth in demand for their skills, forcing some graduates to take jobs in which the skills acquired in their university courses are largely unneeded.

5. Conclusion

The first objective of this paper was to provide a description of the earnings structure by field of study of university graduates at the undergraduate and master's levels. We began by discussing what we mean by an earnings structure: first, that there are statistically significant differences in mean earnings of graduates in fields of study at different levels in this structure; second, that the ranking of fields of study in this structure is reasonably stable over time.

We concluded that there is an earnings structure in this sense at both the undergraduate and graduate levels, but that this structure is far from being an invariant hierarchy of earnings. At the undergraduate level, Medicine and Dentistry have the highest earnings levels, usually followed by Veterinary Medicine and Law. The next group consists of Pharmacy and the engineering fields of study. A fourth group consists of Nursing, Rehabilitation Medicine, business-related courses of study, Elementary/Secondary Teaching and Social Work. The last group consists of a large number of fields of study in the arts, humanities, social sciences, biological sciences and physical sciences.

This last grouping is obviously quite broad. The boundaries between the groups, moreover, are not clear cut. It is often true for some survey (NGS or Follow-Up) that cannot reject the hypothesis that two fields of study in different groups have the same mean earnings. Nonetheless, given the groupings we establish in each of the six surveys we examined, we think that these overall groupings are a reasonable description of the earnings structure at the undergraduate level.

Generally speaking, these results are similar to those found in earlier studies which use more highly aggregated fields of study, in particular, Finnie (1999) and Côté and Sweetman (1998). Our results do serve to point out that aside from a few, relatively small professional programs whose graduates are highly paid, it is very difficult to find consistent, statistically significant differences in mean earnings between fields of study at a level of detail which is something like that faced by a student choosing a program. This is due to a high degree of variance in individual results within fields of study, which in many cases outweighs the earnings differences attributable to field of study.

At the master's level, we would characterize the overall earnings structure in very similar terms to those we just used for the undergraduate level. The earnings structure is even more nebulous at the master's level than at the undergraduate level. We are only able to distinguish two groups of fields of study on the basis of earnings. Roughly speaking, fields of study in the higher earnings group at the master's level were among the higher paid fields of study at the undergraduate level, although there are significant differences in ranking in some instances.

Given the descriptive aims of this study, we have not examined the effects of field of study on earnings in a multivariate analysis in which a large number of other factors affecting earnings are taken into account. Finnie's (1999) results using the same data sources suggest that the field of study effects would be reduced in a multivariate analysis, making it even more difficult to distinguish a structure of earnings by field of study.

One factor we did consider is gender differences. Not only is there a statistically significant effect of gender on earnings once field of study is taken into account, there is also a statistically significant effect of the interaction of gender and earnings. This does not necessarily mean that the earnings ranking of fields of study is different for women and men.

From our data, it is difficult to draw a firm conclusion as to gender differences in the earnings structure by field of study. If we restrict ourselves to fields of study with a significant representation of both women and men, the earnings structures appear quite similar. If we enlarge our analysis to fields of study with a minimal number of either women or men, the earnings structures of the two genders are much less closely related. This may simply be the effect of greater random variation due to smaller sample sizes.

After describing the earnings structure by field of study, we attempted to assess the degree of similarity in the occupational distribution of graduates from various fields of study. We used cluster analysis to group fields of study, based on the occupational distribution of their graduates among minor groups in the 1980 SOC and among four non-post-secondary groups of occupations.

At the undergraduate level, the cluster analysis produced a series of clusters of fields of study in which a high percentage of graduates went into occupations in a specific SOC 3-digit occupation (minor group) and a relatively low percentage went into non-post-secondary occupations. In

addition to these clusters, there was a general cluster of fields of study, characterized by a high proportion of graduates working in non-post-secondary occupations. In the general cluster, managerial occupations and teaching were often significant sources of employment.

In the first group of clusters, graduates from one field of study tended to work in a single SOC 4-digit occupation (unit group) within the minor group on which the cluster was based. Graduates from other fields of study in the cluster worked in a different SOC occupation. For example, graduates in Medicine, Dentistry and Veterinary Medicine all worked in the SOC minor group Health Diagnosing and Treating Occupations, graduates in Medicine as physicians, graduates in Dentistry as dentists, and graduates in Veterinary Medicine as veterinarians. In these clusters, there is a high degree of correspondence between an occupation and a field of study.

In what we called the General cluster, there was often a significant degree of occupational specificity for those graduates in a field of study who did not work in a non-post-secondary occupation. In general, then, there is a high degree of correspondence between field of study and occupation for those graduates who do not work in non-post-secondary occupations. The only real instances of similarity in the occupational distributions of different fields of study occurs when fields of study have a high proportion of graduates working in non-post-secondary occupations.

Which fields of study are found in this General cluster where a large percentage of graduates are unable to find work in post-secondary level occupations? Essentially, fields of study in the humanities, arts, social sciences, commerce, physical sciences and biological sciences. Since this list is much the same as our earlier list of the lowest earnings fields of study, it is not surprising that fields of study in the General cluster tend to have lower average earnings than other fields of study.

At the master's level, employment of graduates in non-post-secondary occupations is much less prevalent. As a result, the General cluster breaks down into a series of clusters made up of a small number of fields of study or a single field of study. With a few exceptions (notably History, Sociology and Political Science), master's level graduates tend to work in occupations closely related to their studies.

What conclusions can we draw from these results? First, at the undergraduate level, graduates from professional programs in health, engineering, law, and teaching tend to have higher earnings and to be more likely to be in occupations directly related to their program of study than other graduates. Second, that beyond a small number of fields of study, it is not easy to establish a structure of earnings by field of study. The best we were able to do is to describe broad groups with a large area of overlap and shifting boundaries. Third, at the master's level, it is also difficult to give more than a vague description of the earnings structure. Fourth, at the master's level, graduates in most fields of study tend to work in occupations closely related to their studies.

Large numbers of graduates at the undergraduate level from programs in the arts, humanities, social sciences, commerce, biological sciences and physical sciences were unable to find work at what we characterize as a post-secondary level in 1992 and again in 1995. This is certainly one of the reasons earnings are lower for graduates in these fields of study than for graduates from professional programs. We are unable to say whether these graduates work outside non-post-secondary occupations as the result 1) of poor labour market conditions in the early 1990's, 2) of increasing skill requirements in non-post-secondary occupations or 3) of faster trend growth in the supply of the skills these graduates have than of the demand for skills of this type. This is certainly an appropriate area for further research.

It is often argued that while undergraduate programs in the arts, humanities and social sciences do not provide specific skills used at work by their graduates, they do provide generic skills which allow their graduates to find work in post-secondary level jobs. The difficulty for this argument in our findings is that graduates in many of these programs are far more likely to be working in data manipulation occupations than as managers. This may be the result of a temporarily depressed labour market.

Another possibility is that a university program in these fields of study plays the role that a high school diploma played in the past. It serves as certification of a general level of literacy and numeracy skills in a context where the required levels of these skills are higher in many occupations than in the past. This certification provides access to jobs where these skills are needed, but these jobs are not necessarily in what are usually considered to be university-level occupations.

Appendix A

Sample Restrictions and Required Cell Sizes

The samples for the 1992 NGS and 1995 Follow-Up were drawn from the 1995 Follow-Up file. The samples for the 1988 NGS and 1991 Follow-Up were drawn from the 1991 Follow-Up file. The samples for the 1984 NGS and 1987 Follow-Up were drawn from the 1987 Follow-Up file, which included respondents in 1984 who were non-respondents in 1987. We included these respondents in our estimates for 1984. The 1995 and 1991 Follow-Up files did not include non-respondents to the Follow-Up. The versions of the Follow-Up files used were the master file versions made available to Human Resources Development Canada under the information-sharing agreements for the National Graduates Surveys and Follow-Up Surveys.

The following criteria were applied in selecting our samples: respondents had to have received a university undergraduate diploma or certificate, bachelor's degree or first professional degree (undergraduate level) or graduate certificate or diploma or master's degree in 1982, 1986 or 1990. They had to have a valid field of study code. To be included in the sample for the NGS, they could not have completed further post-secondary education by the NGS interview and had to be employed full-time at the time of the interview. To be included in the sample for the Follow-Up, they could not have completed further post-secondary education by the Follow-Up interview and had to be employed full-time at the time of the interview.

There were additional restrictions aimed at assuring adequate sample size in field of study cells. These are as follows:

In all of the analysis of variance models reported in Tables 2, 4, 6 and 8, fields of study were included only if they had an actual sample size of 30 or more. The results were reported in Tables 2 and 4 only if this sample size was attained in most of the surveys. The same sample size restriction applied to the fields of study shown in Figures 1,2,3 and 4. In these figures, a field of study was included only if it attained this sample size in all three relevant surveys. This requirement is more restrictive than those used in Tables 9 and 11 so as to reduce the standard errors of the mean, in order to increase the power of the tests of the null hypothesis of equality of means.

Fields of study included in the cluster analyses reported in Tables 9 and 11 had weighted sample sizes of 100 or more. The same restriction applies to the fields of study shown in Figure 5 and those used in the regression reported in Table 10. This criterion was considerably less restrictive than the criterion of an actual sample size of 30 in each field of study used in the analysis of variance models.

The fields of study included in the correlations reported in Table 1 (undergraduate level) had sample sizes of 30 or more. The fields of study included in the correlations reported in Table 3 had sample sizes of 10 or more. The fields of study included in the correlations reported in Table 5 had sample sizes of 30 or more at the undergraduate level and of 10 or more at the master's level. The fields of study included in the correlations reported in Table 7 had sample sizes of 10 or more.

It should be clear that with these differing criteria for inclusion of fields of study in various tables and figures, the number of fields of study included varies widely.

Table A1 below gives the number of respondents at the undergraduate and master's levels and the number included in the analysis of variance models whose results underlie Tables 2 and 4. It should be noted that these models will include some fields of study that met the sample size requirement in at least one survey, but not in enough surveys to be included in Table 2 or Table 4. Most of the loss of respondents from the sample is due to the requirements of being employed full-time and of not having completed further post-secondary education when surveyed.

Table A1 **Number of Respondents and Sample Size for Analysis of Variance Models**

	Undergraduate Level		**Master's Level**	
	Respondents	*Sample*	*Respondents*	*Sample*
1984	10,589	5,417	6,081	2,451
1987	9,527	3,668	5,412	2,155
1988	9,706	5,777	4,886	2,734
1991	9,706	5,378	4,886	2,716
1992	9,425	5,219	5,474	3,359
1995	9,425	4,029	5,474	2,833

Appendix B

COPS Major Field of Study Aggregation—University Level

	COPS TITLE/ University Student Information System (USIS) Title	USIS Code
1	NO SPECIALIZATION	
	-Degree in arts -field not known	00002
	-Degree in science -field not known	00008
	-Unknown	99999
2	ELEMENTARY/SECONDARY TEACHER TRAINING	
	-Elementary/secondary teacher training	11800
3	OTHER TEACHING	
	-Higher education, post-secondary teacher training	12300
	-Kindergarten, pre-school teacher training	13600
4	EDUCATION NON-TEACHING	
	-School librarianship	13801
	-Education administration	13802
	-Education psychology	13803
	-Guidance and counselling	13805
	-Curriculum specialization	13806
	-Measurements and evaluation	13807
	-Education foundations	13808
	-Other non-teaching fields	13899
5	PHYSICAL EDUCATION	
	-Physical education	13900
	-Kinesiology, human kinetics and kinanthropology	14000
	-Recreation	14100
6	MUSIC	
	-Music	20500
7	FINE AND PERFORMING ARTS (EXCEPT MUSIC)	
	-Fine art	20300
	-Other performing arts	20800
8	APPLIED ARTS	
	-Industrial design	21401
	-Other Applied Arts	21499
9	ENGLISH	
	-English language and/or literature	30500
10	FRENCH	
	-French language and/or literature	30600
11	HISTORY	
	-History	30900

12	CLASSICAL AND OTHER LANGUAGES	
	Classics, classical and dead languages	30300
	-Comparative literature	31101
	-Mediaeval languages	31102
	-Asian languages and literatures	31103
	-Slavic languages and literatures	31104
	-Other languages and literatures	31199
13	LIBRARY AND RECORDS SCIENCE	
	-Library science	31200
	-Other records science	31300
14	LINGUISTICS, TRANSLATION AND INTERPRETATION	
	-Linguistics	31400
	-Translation and interpretation	32700
15	MASS COMMUNICATION (EXCEPT JOURNALISM)	
	-Mass communication studies	31700
16	PHILOSOPHY	
	-Philosophy	32100
17	RELIGION AND THEOLOGICAL STUDIES	
	-Religious Studies	32400
	-Theological Studies	32500
18	JOURNALISM	
	-Journalism	31000
19	AREA STUDIES	
	-Canadian Studies	40800
	-Medieval Studies	40910
	-Asian Studies	40920
	-Slavic Studies	40940
	-Other Studies	40999
20	COMMERCE	
	-Commerce, management, business administration, administrative studies/science	41200
21	SPECIALIZED ADMINISTRATION	
	-Public Administration	41401
	-Health Administration	41402
	-Hotel and Food Administration	41403
	-Other Specialized administration studies	41499
22	ECONOMICS	
	-Economics	42700
23	GEOGRAPHY	
	-Geography	43000
24	LAW	
	-Law and jurisprudence	43300

25	PLANNING AND RESOURCE MANAGEMENT	
	-Regional, rural, city planning and community development	44008
	-Resource management and environmental studies	44010
26	POLITICAL SCIENCE	
	-political science	44300
27	PSYCHOLOGY	
	-psychology	44600
28	SOCIOLOGY	
	-Criminology	41300
	-Sociology	45200
29	SOCIAL WORK, SOCIAL WELFARE	
	-Social work and social welfare	44900
30	OTHER SOCIAL SCIENCES	
	-Anthropology	40300
	-Archaeology	40600
	-Demography	41500
	-Secretarial Studies	44700
	-Military Studies	45500
	-Other Social Services	45700
31	ANIMAL AND PLANT SCIENCES	
	-Animal Science	50310
	-Plant Science	50322
32	AGRICULTURE (EXCEPT ANIMAL AND PLANT SCIENCES)	
	-Soil Science	50326
	-Other Agriculture	50399
33	BIOLOGY	
	-Genetics	50910
	-Microbiology	50912
	-Other biology	50909
34	FOOD AND HOUSEHOLD SCIENCES	
	-Food Science and Nutrition	51808
	-Other household science and related	51899
35	VETERINARY SCIENCES AND MEDICINE	
	-Veterinary medicine	52100
	-Veterinary Science	52200
	-Veterinary medicine specialties	52300
36	OTHER BIOLOGICAL SCIENCES	
	-Biochemistry	50600
	-Biophysics	51200
	-Botany	51500
	-Fisheries and wildlife management	51600
	-Zoology	52400

37	ARCHTECTURE	
	-Architecture	60300
38	CHEMICAL ENGINEERING	
	-Chemical engineering	60600
39	CIVIL ENGINEERING	
	-Civil Engineering	60700
40	ELECTRICAL ENGINEERING	
	-Electrical engineering	60900
41	MECHANICAL ENGINEERING	
	-Mechanical engineering	61200
42	OTHER ENGINEERING	
	-Aeronautical and aerospace engineering	60500
	-Design, systems engineering	60800
	-Industrial engineering	61000
	-Mining engineering	61100
	-Metallurgical engineering	61300
	-Other engineering	61400
	-Engineering science	61500
	-Engineering general	61600
43	FORESTRY	
	-Forestry	62000
44	OTHER APPLIED SCIENCE	
	-Landscape architecture	62200
45	DENTISTRY	
	-Dentistry (professional program)	70300
	Dentistry specialties	70400
46	MEDICINE	
	-Medicine (professional program)	70500
47	BASIC MEDICAL SCIENCE	
	-Anatomy	70604
	-Biochemistry	70606
	-Biophysics	70608
	-Embryology	70610
	-Endocrinology	70612
	-Genetics	70614
	-Histology	70616
	-Neurophysiology	70622
	-Pharmacology	70626
	-Physiology	70628
	-Other basic sciences	70699
48	MEDICAL SURGICAL SPECIALITIES	
	-Medical specialties	70800
	-Surgical specialties	71200

49	NURSING	
	-Nursing	71500
50	PHARMACY	
	-Pharmacy	72100
51	REHABILITATION MEDICINE	
	-Aural and oral rehabilitation	72702
	-Occupational therapy	72704
	-Physical therapy	72706
	-Other rehabilitation	72799
52	OTHER HEALTH	
	-Immunology	71006
	-Microbiology	71010
	-Pathology	71014
	-Other paraclinical sciences	71099
	-Optometry	71800
	-Epidemiology and public health	72400
	-Medical technology	73600
	-Other health professions and occupations	79900
53	COMPUTER SCIENCE	
	-Computer science	80600
54	MATHEMATICS	
	-Mathematics	81200
55	CHEMISTRY	
	-Chemistry	81500
56	GEOLOGY	
	-Geology and related	81800
57	PHYSICS	
	-Astronomy	83001
	-Aerospace science	83002
	-Other physics	83099
58	OTHER PHYSICAL SCIENCES	
	-Metallurgy, materials science	82100
	-Climatology	82404
	-Other meteorology	82499
	-Oceanography and water studies	82700

Appendix C

The Tukey-Kramer Procedure for Multiple Comparisons and the Description of the Earnings Structure

This discussion of multiple comparisons and the Tukey-Kramer method is adopted from the description of PROC GLM in the SAS/STAT® User's Guide,[14] in particular, the section "Comparisons of Means," pp941-948. To identify a structure of earnings by field of study as we define it, we need to know the fields of study for which the null hypothesis of equality of mean earnings can be rejected. The simplest approach to this would be to conduct a series of t-tests of the equality of means for each pair of fields of study. With 30 fields of study, this would require 870 pairs of t-tests; with 20 fields of study, 190 pairs of t-tests.

A serious problem arises with a large number of simple comparisons such as those described in the preceding paragraph. Suppose that the significance level of each t-test were set to 1% and that the test statistics are independently distributed. Then with 30 fields of study, the probability of rejecting the null hypothesis of equality of means in at least one instance where it is correct is $1-.99^{435} = .99$, and with 20 fields of study this probability is .85. The probability of making at least one Type I error (rejecting the null hypothesis when true) is referred to as the experiment-wise error rate. A significance level which controls the experiment-wise error rate is referred to as the maximum experiment-wise error rate (MEER).

For our comparisons of means of earnings by field of study, we used the Tukey-Kramer method of multiple comparisons. The Tukey-Kramer method rejects the null hypothesis of equality of two means y_i and y_j in a comparison of k means if the test statistic

$$\left|y_i - y_j\right| / s\sqrt{(1/n_i + 1/n_j)/2} > q(\alpha, k, v)$$

where n_i and n_j are the cell sizes for the i^{th} and j^{th} cells, v is the degrees of freedom, s is the root mean square error with v degrees of freedom (v = N – k, where N is the number of individuals in the sample). The test statistic $q(\alpha,k,v)$ is the α-level critical value of a studentized range distribution of k independent normal random variables with v degrees of freedom.

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[14] SAS Institute, *SAS/STAT® User's Guide, Version 6, Fourth Edition, Volume 2*, Chapter 24, "The GLM Procedure," especially pp941-948.

This is the method recommended by the SAS/STAT® User's Guide for controlling the MEER with unequal cell sizes (there are not equal numbers of graduates in each field of study cell). It also permits output with the Lines option, as shown below. This option gave a complete list of groups of fields of study within which the null hypothesis of equality of means cannot be rejected. These groups have the property that if $mean_a > mean_b > mean_c$ and field of study *a* and field of study *c* are in the group, then field of study *b* must be in the group as well. We regard a group of fields of study for which we cannot reject the null hypothesis of equality of mean earnings as a group of fields of study at the same level in the earnings structure.

According to the description of the Lines option in the SAS/STAT® User's Guide, unequal cell sizes "may lead to somewhat liberal tests if the cell sizes are highly disparate." (p944) This might mean that in some instances the appropriate groups of fields of study are even broader than those that we list and the earnings structure even less clear cut than the structure we describe.

The pages which follow are a sample output from PROC GLM using the Tukey-Kramer method with the Lines option to compare mean earnings by fields of study at the undergraduate level in the 1992 NGS. As in all of our comparisons of means, the significance level α (MEER) is set to .05.

Page 3 to page 4 of the output show the results of the Lines option. Groups of fields of study within which the null hypothesis of equality of means cannot be rejected are marked with the same letter. Note that group A does not overlap with any other group, while groups C, D, E and F all overlap with group B. We described the earnings structure as consisting of three groups in this case: group A, group B and group F, since these three groups cover all of the fields of study and have the least overlap.

In general, we constructed our earnings structures as follows:

1. Select the highest ranking earnings group.
2. a) If this group does not overlap with any other group, select the next highest ranking earnings group.
   b) If this group does overlap with one or several other groups, select the group with the least overlap (lowest value of the highest earnings of an element of the group).

3. Continue the process until a group containing the field of study with the lowest mean earnings is reached.

General Linear Models Procedure

Class Level Information

Class	*Levels*	*Values*
COPSFOS	39	1 2 3 5 7 8 9 10 11 17 20 21 22 23 24 25 26 27 28 29 32 33 34 35 36 38 39 40 41 42 45 46 49 50 51 52 53 54 55

Number of observations in data set = 5219

Dependent Variable: MJOBERN2

Source	*DF*	*Sum of Squares*	*Mean Square*	*F Value*	*Pr > F*
Model	38	186305282655.0900000	4902770596.1866000	9.96	0.0001
Error	5180	2548584587051.7500000	492004746.5350860		
Corrected Total	5218	2734889869706.8400000			

R-Square	*C.V*	*Root MSE*	*MJOBERN2 Mean*
0.068122	66.64340	22181.18000772	33283.38762215

Source	*DF*	*Type I SS*	*Mean Square*	*F Value*	*Pr > F*
COPSFOS	38	186305282655.0910000	4902770596.1866100	9.9	0.0001

Source	*DF*	*Type III SS*	*Mean Square*	*F Value*	*Pr > F*
COPSFOS	38	186305282655.0930000	4902770596.1866600	9.96	0.0001

Tukey's Studentized Range (HSD) Test for variable: MJOBERN2

Note: This test controls the type I experimentwise error rate, but generally has a higher type II error rate than REGWQ.
Alpha= 0.05 df= 5180 MSE= 4.92E8
Critical Value of Studentized Range= 5.484
Minimum Significant Difference= 14104
WARNING: Cell sizes are not equal.
Harmonic Mean of cell sizes= 74.38943
Means with the same letter are not significantly different.

Tukey Grouping					Mean	N	COPSFOS
			A		75912	34	45
			B		46260	77	50
			B				
			B		45944	36	52
			B				
	C		B		44461	128	46
	C		B				
	C		B	D	42341	44	35
	C		B	D			
	C	E	B	D	38507	144	24
	C	E	B	D			
	C	E	B	D	38426	47	39
	C	E	B	D			
	C	E	B	D	37909	132	40
	C	E	B	D			
F	C	E	B	D	37052	231	49
F	C	E	B	D			
F	C	E	B	D	36677	127	42
F	C	E	B	D			
F	C	E	B	D	36531	81	39
F	C	E	B	D			
F	C	E	B	D	36460	213	53
F	C	E	B	D			
F	C	E	B	D	35899	89	29
F	C	E	B	D			
F	C	E	B	D	35681	138	41
F	C	E	B	D			
F	C	E	B	D	35350	103	51
F	C	E	B	D			
F	C	E	B	D	35273	44	21
F	C	E	B	D			
F	C	E	B	D	35020	752	2
F	C	E	B	D			
F	C	E	B	D	34519	133	54
F	C	E	B	D			
F	C	E	B	D	32614	689	20
F	C	E		D			
F	C	E		D	31757	206	1
F	C	E		D			
F	C	E		D	31595	37	25
F	C	E		D			
F	C	E		D	31336	116	3
F		E		D			
F		E		D	30046	109	22
F		E		D			
F		E		D	29971	34	32
F		E		D			
F		E		D	29255	47	17

F	E	D			
F	E	D	28769	199	2
					8
F	E	D			
F	E	D	28419	155	5
F	E				
F	E		28127	55	1
					0
F	E				
F	E		28022	45	2
					3
F	E				
F	E		27560	109	2
					6
F	E				
F	E		27349	83	1
					1
F	E				
F			27278	72	3
					6
F	E				
F	E		26929	56	3
					4
F	E				
F	E		26290	31	8
F	E				
F	E		26197	61	5
					5
F					
F	E		26053	225	2
					7
F	E				
F	E		25825	120	9
F	E				
F	E		24605	177	3
					3
F					
F			23025	40	7

References

Appleby, J., Boothby, D., Rouleau, M. and G. Rowe. (1999) *Rate of Return to Education Using the LifePaths Model.* Applied Research Branch, Human Resources Development Canada, unpublished.

Boothby, D. (1999) *Literacy Skills, the Knowledge Contents of Occupations and Occupational Mismatch*, Working paper W-99-3E. Ottawa: Applied Research Branch, Human Resources Development Canada.

Côté, S. and A. Sweetman. (1998) *Does It Matter What I Study? Post-Secondary Field of Study and Labour Market Outcomes in Canada*, WRNET 97-04, unpublished.

Dodge, D. and Stager D. (1972) "Economic Returns to Study in Science, Engineering and Business," *Canadian Journal of Economics*, 5(2), pp. 182-198.

Finnie, R. (1999) *Earnings of University Graduates in Canada by Discipline: What You Study Matters—An Econometric Analysis of Earnings Differences of Bachelor's Level Graduates*, Research paper R-99-13E.b. Ottawa: Applied Research Branch, Human Resources Development Canada.

Mehmet, O. (1977) "Economic Returns on Under-Graduate Fields of Study in Canadian Universities: 1961 to 1972," *Industrial Relations/Relations industrielles*, (32) pp.321-339.

Vaillancourt, F. (1996) *The Private and Total Returns to Education in Canada, 1990.* CRDE, Université de Montréal, unpublished.

Vaillancourt, F. (1998) *The Returns to Education in Canada: 1985 and 1990.* CRDE, Université de Montréal, unpublished.

Wannell, T. and N. Caron. (1994) *The Gender Earnings Gap Among Recent Postsecondary Graduates, 1984-92*. Ottawa: Analytic Studies Branch, Statistics Canada.